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ART. I.—*Indian Mounds and Skulls in Michigan. Results of Explorations of* Mr. HENRY GILLMAN. From the Sixth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology, Harvard College, Prof. JEFFRIES WYMAN, Curator.

A COLLECTION made by Mr. Henry Gillman from a mound on the Detroit River, Michigan, explored by him for the Museum, consists of human remains and various objects buried with the dead. The latter are of the common kinds, such as stone chisels, one of much beauty made of diorite and highly polished, a spear point, arrow points, stone pendants, a stone boring tool, beads and ornaments made of shell and copper, an implement made of an antler, a miniature vase of the size of a common thimble, and two large and perfect vases of the oval pattern and ornamented over the whole surface with cord marks.

One of the skulls, that of a fully adult person, is worthy of notice for its diminutive size, and for a remarkable extension of the lines for the attachment of the temporal muscle toward the top of the head. The average capacity of the Indian cranium, as given in the tables of Morton and Meigs, is eighty-four cubic inches, and the minimum observed by them sixty-nine cubic inches. That from the Detroit River mound measures only fifty-six cubic inches, or less than sixty-seven per cent of that of the average Indian. In ordinary skulls the ridges of the temporal muscles on the two sides of the head are separated by a space of from three to four inches, seldom less than two, while in the Detroit mound skull this space measures only three-quarters of an inch; and in this respect it presents about

the same conditions as the skull of a chimpanzee. As the two other crania from the same mound offered no such peculiarities, the skull which has just been described must be considered simply as an extreme case of individual variation from the ordinary form. There are no signs of artificial deformity.

The single tibia accompanying this collection is somewhat flattened.

Mr. Gillman, under an appropriation made by the Trustees, has explored a series of mounds at the head of St. Clair River, and the collections made by him have been received and were accompanied with the following report:

The mounds situated at the head of the St. Clair River extend from south of Fort Gratiot for one and one-half miles northward, along the west shore of the river and of Lake Huron. It is altogether probable that they reach much farther, both northward and southward; but I have traced, examined and fully identified them for the distance mentioned. Similar works have been found on the opposite side of the river, in Canada. Isolated mounds in the interior also exist, an interesting example of which is seen on the west shore of the Black River (a tributary of the St. Clair), at a point about one and three-quarter miles southwest of Gratiot; the mound referred to having been exposed, some years ago, by the grading of a road through it, which, as usual, resulted in the loss of a large amount of valuable relics.

With few exceptions, all these mounds have a general resemblance, and bear the appearance of terrace-like embankments from ten to twenty and twenty-five feet in height; they are much longer than wide, and run nearly parallel to the general direction of the river and lake shore, which here does not vary much from north and south. They are mostly of the Drift formation, subsequently modified or added to by man for the various objects for which they were occupied, whether for the purposes of interment, habitation, or the manufacture of the rude implements connected with the daily life of that period; and, from the topographical features and the geographical position, they must have formed favorite places of retreat in war time.

Mound No. 1 is composed chiefly of sand and gravel, is about two hundred feet long by fifty feet wide, and is fifteen feet above the level of the river. It has rather abruptly-curving sides, and is built on a slope of the ridge, of Drift formation, on which the village of Gratiot stands.

A large excavation, made about fifty feet from the south end of the mound, disclosed the remains of four human bodies, at a depth of four feet from the surface. In an area of about ten

feet square the four crania, with a portion of the accompanying bones, were taken out, but were in so decayed and tender a condition that, with the exception of a skull and a few of the long bones and vertebræ, they mostly fell to pieces. The bodies evidently were buried in a sitting posture. This was very apparent in one case, where the femora were found bent upon and above the tibiæ, the vertebræ, etc., resting upon these, while the skull lay on top, face downward, as though it had leaned forward originally, and had finally fallen over into that position. This cranium is that marked Skull No. 1, Mound No. 1; and the vertebræ and other bones thereto belonging may be found correspondingly marked. With these remains were associated fragments of pottery, the bones of fishes and birds, flint chips, and some stone implements of the rudest character. These last were mostly water-worn boulders, apparently used as hammers, and almost invariably shattered; and net sinkers, flattish, irregularly-elliptical stones, notched on the edges or partially grooved toward the center. It is interesting to notice that the tibiæ present the peculiar compression which I have found so marked a characteristic, and in such extreme degree in the tibiæ from the mounds on the Detroit River and the River Rouge, Michigan, establishing the fact that these, too, were platycnemic men.

After excavating to the depth of six feet, the coarse gravel of the Drift was encountered; but no further objects of interest being met with, the opening was extended in other directions to the westward, so as to open a lateral trench through the mound. This revealed several fireplaces, solid beds of black ashes from one foot to eighteen inches thick, with fragments of pottery and bone, flint chips, sinkers and broken hammers interspersed. The fireplaces were invariably at or near the surface of the mound, showing it to have been occupied for habitation subseqently to being used for burial purposes. Openings made at two points, about fifty feet from the north end of the mound, and also at a third point, half-way between these and the first excavation, added no facts of special interest. Two excavations were then made at twenty-five feet from the south end of the mound, showing fireplaces with the beds of black ashes two feet thick, and intermingled relics similar to those of the fireplaces already mentioned. Some of the fragments of pottery taken out here were uncommonly thick and coarse. Beneath were small pieces of the bones of man, but nothing further worthy of mention. The encroachment of the town on this mound, and on those to the west of it, prevented a more satisfactory examination.

The oldest residents (some born and brought up here) knew

nothing of the character of the mound, though they remember that, many years ago, it was covered with a large forest growth.

Mound No. 2, which lies two hundred feet northwest of Mound No. 1, is over five hundred feet in length by from one hundred to one hundred and fifty feet wide; and of the general height of twelve feet above the level of the St. Clair River. It is bounded on the north by a small stream known as McNeil's Creek, which also runs southwardly all along its eastern slope, as well as a part of the south end of the mound. The ordinary observer will scarcely fail to notice that this mound is something more than the work of nature. Its sides have a graceful, gradual slope, with the exception of the side fronting the river, which is abrupt and terrace-like, even where not washed by the creek. Between the creek and the River St. Clair is some low lands with ponds, where are a few outlying mounds, small and of slight elevation. About two hundred feet of the south end of Mound No. 2 is clear of trees, except on the sides, and is covered with a smooth green turf. Excavations were made in a number of places, showing that this entire end of the mound was covered with a solid crust of black ashes from eighteen inches to two feet thick. So hard and solid was this crust that layers of it in large pieces several inches square and thick were taken up unbroken. Fragments of pottery showing a great variety of patterns, bones of animals, birds and fishes (some of the larger bones evidently smashed), flint flakes and chips, with stone implements, consisting principally of arrowheads, hammers and sinkers, were found intermixed with the ashes. The abundance of the sinkers and particularly of the broken hammers is a remarkable feature. Though such rude utensils, a selection from them is preserved, so as to give an idea of their character. I have not found elsewhere a similar condition of things, and believe that this end of the mound furnishes a nearer approach to the "refuse heaps" of the Atlantic coast than anything I have seen elsewhere on the shores of the Great Lakes. The absence of the shell deposit, however, makes a marked difference. I cannot find that those ancient inhabitants of this region had much recourse to shell-fish as an article of diet. The great abundance of fishes, and the ease with which they were captured, together with the multitude of land game, left them under no necessity to use the inferior fresh-water mussels for food.

From the large quantity of pottery fragments and broken hammers, together with the thick bed of ashes covering so wide an area of this mound, I incline to think that this must have been a point where the manufacture of their pottery was carried on to an unusual extent. The broken hammers may be ac-

counted for by their having been fractured in pounding the grains used as food, and in cracking the bones of animals for the extraction of the marrow, indications of which are not wanting. The pottery found in both these mounds exhibits an unusual variety of patterns; though not a single utensil was taken out entire.

From want of time the investigation of the northern part of the mound, which is elevated at its center from two to three feet above the portion covered with the ash-bed, was confined to three points. No additional information was obtained, however, further than establishing for it a like origin with the other mounds.

All the northern portion of the mound and also the sides of the southern portion are covered with a large second growth of trees. These consist chiefly of White Pine (*Pinus strobus* L.), Scarlet Oak (*Quercus coccinea* Wang.), White Oak (*Q. alba* L.), and Basswood (*Tilia Americana* L.). The trunks of some of these trees have a diameter of from eighteen inches to two and one-half feet. A few decayed stumps of the original forest still remain. These average four feet in diameter.

Mound No. 3.—After the exploration of four other mounds, three lying northward, the fourth northwestward of Mound No. 2, which contributed no additional facts of particular value, other than their identity of origin with the rest of the group, attention was next directed to Mound No. 3, which proved to be the most interesting of the entire series. This mound is situated three-quarters of a mile northeastward of Mound No. 1. It is about five hundred feet in length, and in breadth varies from seventy to ninety feet; while its height above the surface of Lake Huron is twelve feet, or not more than five feet above the general level of the surrounding land. In general direction it corresponds to the other mounds, and there is little in its appearance to suggest its character or call the attention of any other than a practised eye.

A large excavation was made at its widest part, and about its center. Within two feet of the surface the bones belonging to a single body were unearthed, but in so tender a condition from age that they mostly crumbled to pieces. A few bones of birds and fishes were found with them. Some of the decayed roots of an oak tree stump, ten feet to the westward (and which will be further alluded to), had grown over and around these bones. The excavation was deepened, widened and carried farther to the eastward, opening a trench to the depth of six feet, but only small fragments of human bones resulted. The trench was then opened to the westward, toward the stump of the oak. When at the depth of five feet we came to a skull

(No. 1, Mound 3). Some of the bones first taken out overlay this, and decayed roots of the oak, as thick as a man's arm, stretched above it. The other bones belonging to the body appear dwarfish. It was buried with the head to the east, and the legs seem to have been drawn up, and not stretched out at full length. On removing these remains, we found, immediately underneath, a third body, placed so closely that the skull of the upper rested on that of the lower. At the head was a large quantity of the bones of birds and fishes, in a compact mass, as though once held in some wrapping or vessel which had decayed. These were pressed against the skulls, so that in some cases they adhered to them, and are, no doubt, the remains of the food placed with the dead. Such of the bones as could be removed are preserved, but a great portion crumbled to pieces. This body was buried with the head to the eastward. The roots of the oak tree had penetrated the bones in many cases, the long roots presenting some interesting examples of this, as the roots in their natural growth had first filled, then burst, the bones, so that in several instances the parts of the bone surrounded the now decayed root, imbedded in it. Such pieces as held together are forwarded. This tree, which evidently belonged to the second growth of timber, was, I think, a scarlet oak (*Quercus coccinea* Wang.), as the majority of the wood covering the southern half of the mound is of this species, together with the white pine. The decayed stump was two feet in diameter at the base, and at one foot above the ground divided into three trunks or main branches, each nine inches in diameter. These had been cut down, apparently, many years ago; and as between the first and two subsequent burials must have occurred, in all probability, some lapse of time, and the oak must have sprung up, reached its growth, been cut down, and its stump finally have decayed long afterward, some slight idea may be had as to the age of the first burial.

The trench was now opened to the oak stump, when, from directly beneath it, skull No. 3 was taken out with the accompanying bones. Upon this skull lay a plate of mica, five by four inches, of a quadrilateral shape, the corners worn off. A pebble of water-worn coral rested upon the mica, as if to keep it in place. About the neck of the deceased a necklace of remarkable construction had apparently been hung. This uncommon ornament was composed of the teeth of the moose, finely perforated at the roots, alternating with wrought beads of copper of different lengths, and the perforated bones of birds stained a fine green color, the stain, in the few pieces preserved, being wonderfully fresh. Small portions of the cord to which

they had been attached are still partially preserved and remain in the apertures of the copper beads. I suppose that the teeth alternated with the copper beads and the stained bones. One copper bead, which adheres by its oxidation to the perforated part of a tooth, sustains this conclusion. A rude stone axe, partially polished, lay beside these remains. All indicated that the dead had been peculiarly honored in his burial, and that he had been, perhaps, a noted personage.

Immediately to the northward of this body another was taken out, skull No. 4, with the remaining bones. These were under the edge of the oak stump, and, as well as the remains No. 3, were surrounded with masses of roots. Both bodies lay nearly side by side, and at the same vertical plane, five feet below the surface. As in the other cases, the bones of birds and fishes were found with the remains, but in small quantity.

The excavation was next carried southward, through the center of the mound, for a short distance; but no relics being met with other than a few fragments of broken hammers and flint chips, it was next opened in the opposite direction, northward, thus giving it the form of an irregular Latin cross. When a few feet to the northward of the remains last taken out (No. 4), we came upon skull No. 5, and following up the indications, recovered such of the remaining bones as could be preserved. With this body a flint arrowhead and some other rude stone implements were found: also a number of small shells, the species of which I have not determined, but which appear to have been used for some special purpose, perhaps as ornaments, as they were ground smooth at the base. About twelve of these were recovered, but there must have been many more originally, as a large number of them crumbled to dust, and also some of them might easily have been overlooked. A short distance westward of the last relics, skull No. 6 was taken out. The accompanying bones, as in the cases of the others, were very tender, and it was with extreme difficulty that any of them were recovered. The tibiæ exhibited the compression previously referred to in a marked degree. A large mass of fish bones lay in front of this body, which, like the previous remains (skull No. 5, etc.), was buried placed on its right side with the head toward the east, and the limbs drawn up closely to the chest. It is possible that they may have been buried in a sitting or crouched position, and have afterward fallen over; but I think they were buried as first mentioned. The absence of pottery with the interments in this mound is worthy of note, only two fragments being found in any part of the mound, and these apparently accidentally dropped.

Isolated excavations in different places throughout the ex-

tent of Mound No. 3, as also in a mound sixty feet to the west of it, contributed nothing specially entitled to record.

Mounds Nos. 4, 5, etc.—Mound No. 4 is eight hundred feet northeast of Mound No. 3. It is three hundred feet long by from thirty to fifty feet wide, and is a low sandy ridge with a series of nine conical elevations running along its length, and rising two or three feet above its general level, they having a diameter of from twenty-five to thirty feet.

Mound No. 5 is fifty feet to the westward of Mound No. 4, and is of a conical shape, forty feet in diameter, and nearly twelve feet above the level of Lake Huron, being between three and four feet higher than No. 4. Two other mounds of a smaller size but similar shape lie to the north of it.

From Nos. 4 and 5 were obtained a few stone implements, fragments of bones and pottery, with flint chips and the usual boulder-hammers, mostly fractured. Our limited time prevented as thorough an investigation of these mounds as their appearance certainly warrants. I believe the removal of those conical elevations in Mound No. 4 would be rewarded with interesting discoveries.

Other mounds to the northward and westward. belonging to the series, were also examined to the extent of confirming their claims to a like origin with those more thoroughly explored. A mound south of Mound No. 1 (the first investigated) contributed a few stone implements, which are forwarded. The large implement appears to me to resemble a spade, but may have been designed for some other use than that apparently indicated.

In conclusion, I would say that the facts observed fully prove this extensive group of mounds a rich field for more exhaustive research. And here I repeat the interesting fact that all the tibiæ unearthed invariably exhibited the compression or flattening characterizing platycnemic men. Unfortunately the bones generally crumbling to pieces prevented satisfactory measurements. But sufficient evidence was obtained (in connection with my discoveries in other parts of Michigan) to establish the point that this race, from the Detroit River to the St. Clair and Lake Huron, was marked with platycnemism to an extreme hitherto unobserved in any other part of this country, or perhaps any other country in the world. I cannot but believe, from what I have seen, that future investigation will extend the area in which this type of bone is predominant to the entire region of the Great Lakes, if not of the Great West; or, in other words, that at least our northern "mound-builders" will be found to have possessed this trait in the degree and to the extent denoted. I am unable to say whether this peculiarity prevails in our modern Indian or not.

With the exception of the rude stone hammers and the sinkers, the number of perfect stone implements seems to me unusually small throughout this entire series of mounds. The question arises: Had this people the habit of sometimes breaking the stone implements cast into the burial mounds. Or were broken ones selected for this purpose as being of little other use?

ART. II.—*Silt Analyses of Mississippi Soils and Subsoils;* by EUGENE W. HILGARD, State Geologist of Mississippi.

THE results here communicated are the first-fruits of an investigation on the physical constituents of soils and clays, undertaken with the aid of the "churn elutriator" for silt analysis, described in another paper. While far from being as complete or satisfactory as I could desire, there is much that is suggestive of the direction to be pursued in the farther prosecution of the research, and of the importance of the results to be attained. The necessary interruption of the work on my part, for some time to come, may serve as an additional apology for an otherwise somewhat premature publication.

The materials of which the silt analyses are here given were chosen as typical representatives of the more important varieties of soils in the State of Mississippi. For reasons repeatedly explained, I have, in most cases, preferred to deal with the subsoil instead of the soil itself, whose organic ingredients materially interfere with the operations of analysis, as well as with the interpretation of the results. The general differences between the soil and subsoil, in ordinary cases, are well understood; and for general research and comparison, the latter is much more available. I have nevertheless, in one case, analyzed the soil and subsoil (206 and 209 of the table) for comparison; the differences falling, as will be seen, just where they would be expected. The deficiency in the summing up of the "*soil*" arises mainly, of course, from the dissolution and loss of vegetable matter.

As a standard for comparison and reference, I place first in the table a very pure, highly plastic pipe-clay; probably as free from foreign admixtures as a sedimentary clay can well be, the sediments being exclusively white quartz grains, sharp and angular. It resembles kaolin, and is probably directly derived from the Carboniferous fire-clays.*

* Miss. Rep., 1860, p. 34 and ff.

Silt Analyses of Mississippi Soils and Subsoils.

Designation of Materials.	Diameter. (Millimeters.)	Velocity (Hydr. V.). Millimeters per Second.	DRIFT.	UPLAND. YELLOW LOAM. SANDY.			LOAM.			TERTIARY. CLAY.				MISSISSIPPI BOTTOM. CHAMPLAIN. SWAMP RIVER.		MODERN. RIVER DEPOSIT.			DELTA.		Velocity (MM.).
			238	248	165	206	209	397	219	173	230	246	196	390	237	365	377	395			
			White Pipeclay, Tishomingo Co.	Tallahoma Subsoil, Jasper Co.	Lt. Flatwoods Soil, Chickasaw Co.	Pine Hill Soil, Smith Co.	Pine Hill Subsoil, Smith Co.	Oxford Subsoil, Lafayette Co.	Table Land Subsoil, Benton Co.	Prairie Subsoil, Monroe Co.	Hy. Flatwoods Soil, Pontotoc Co.	Red Hills Subsoil, Attala Co.	Hog Wallow Subsoil, Jasper Co.	Buckshot Soil, Issaquena Co.	Loess, Claiborne Co.	Talahatchie Soil, Panola Co.	Frontland Subsoil, Sunflower Co.	Dogwood Ridge Soil, Coahoma Co.	Southwest Pass, Plaquemine Par.	Southwest Mudlump, Plaquemine Par.	
1 Coarse Grits,	1·0 to 3·0			6·94	2·90	0·36	0·36		} 0·23	} 2·10	0·33	} 1·97	0·83	0·09	} 0·24	} 0·09					
2 Fine "	0·5 to 1·0			17·65	6·96	2·98	0·83				0·35		1·19	0·05							
3 Coarse Sand,	80 to 90 / 180	64		18·81	2·81	6·62	6·21		1·47			0·72	1·96		0·37	0·04	} 0·32	0·15	} 0·18	} 0·10	64
4 Medium "	50 —55 "	32	} 0·06	10·16	4·41	7·75	3·38	} 0·79	2·33	} 0·62		2·32	1·64	0·36	0·61	0·05					32
5 Fine "	25 —30 "	16		2·66	3·13	3·01	3·85		1·17			2·09	0·88		0·93	0·21	2·97		0·47	5·02	16
6 Finest "	20 —22 "	8	0·08	1·66	2·02	1·59	1·49	0·18	0·78	0·20	0·23	0·70	0·26	0·31	1·65	1·30	2·41	3·74	7·03	3·68	8
7 Dust "	12 —14 "	4	0·02	1·02	2·23	1·19	0·64	0·78	0·76	1·26	0·18	1·29	0·19	0·27	1·95	2·68	16·90	21·49	12·38	5·34	4
8 Coarsest Silt	8 — 9 "	2	0·04	0·88	5·06	3·56	2·63	3·56	9·79	2·92	1·61	1·81	2·49	1·56	14·25	9·38	19·79	21·83	13·27	10·09	2
9 Coarse "	6 — 7 "	1	0·08	1·96	9·67	6·50	5·40	13·12	7·26	7·36	2·66	3·60	3·67	2·23	16·20	9·88	13·90	14·01	15·87	5·58	1
10 Medium "	4 — 5 "	0·5	0·08	7·89	14·18	13·97	7·77	16·64	13·14	8·81	9·13	2·73	5·39	3·68	20·08	20·37	4·27	9·93	8·25	9·54	0 5
11 Fine "	2·5— 3 "	0·25	2·00	8·40	22·03	14·20	16·65	27·28	15·07	7·85	26·64	13·30	10·31	8·97	5·59	19·79	1·89	9·58	7·26	8·01	0·25
12 Finest "	0·1— 2 "	< 0·25	21·15	15·53	15·62	29·36	37·75	18·87	26·50	35·22	32·35	25·33	24·18	38·19	33·38	25·30	30·08	8·65	19·67	34·46	< 0·25
13 Clay,	?	< 0·0023	74·65	8·63	7·86	4·58	10·70	17·23	19·19	33·16	25·43	40·25	47·03	44·30	2·51	9·64	5·51	10·35	12·20	18·18	?
			98·16	99·28	98·68	95·67	97·77	98·35	97·65	99·50	97·87	96·11	100·00	100·01	97·74	98·73	98·04	99·72	96·58	100·00	
Compactness (resistance to tillage),			97·80	32·56	45·33	48·14	45·10	63·38	60·82	69·77	84·47	78·88	81·52	89·46	41·48	54·63	37·48	28·57	39·13	60·65	
Porosity,			0·36	59·55	40·40	37·89	47·13	20·23	26·04	17·04	6·40	39·18	10·12	4·87	38·44	23·63	58·25	61·50	49·20	28·81	
Hygroscopic moisture (+7° to +21),			9·09	1·80	3·36	2·48	7·69	8·79	7·21	11·35	9·33	18·60	14·48	14·31	4·18	6·12	5·68	3·95			
Ferric oxide,			0·13	1·10	(1·45)	1·25	4·15	2·53	5·11	5·42	(5·90)	10·50	4·00	(5·82)	3·27	2·58	2·31	2·69			

Of the "Upland" soils in the foregoing table, Nos. 248, 206, 209, 397, 219 and 173, are properly of the "Yellow Loam" age, *i. e.*, of the end of the Drift period;* while 165 is one of the two chief varieties of soils occurring in the "Flat Woods," a level area bordering on the Cretaceous, and mostly characterized by the occurrence of the Lower Tertiary clays near the surface. The *light* soil (165) occurs in irregular strips and patches; it is very easily tilled at all times; all rain water is promptly absorbed; but it is too "open," droughty, and does not hold manure at all.

No. 248 forms a stratum three feet thick, on the ridges east of Tallahoma Creek, Jasper County, Miss. By its disintegration, it forms a deep and extremely sandy soil, which is injured by high winds carrying away its finer parts. It has, however, yielded good crops of corn and cotton for fifteen years without manure, though liable to injury from drought.—Nos. 206 and 209 are typical of the "Pine Hill" region of South Mississippi, the home of the long-leaved pine. The soil is very "light" and easily tilled, but not nearly as "open" as the preceding two. It is materially improved by the admixture of the subsoil, No. 209; which enables it to hold manure, being what would be termed a "sandy loam."

Nos. 397 and 219 are typical of the cotton uplands of Western Mississippi and Tennessee; 219 being of the first quality; 397 a second rate soil. Their prominent characteristic is an excessive and most distressing proneness to denudation or "washing," in consequence of a want of perviousness, together with the property of promptly swelling up, on contact with water, into a loosely gelatinous condition, in which they readily diffuse in water. From the same cause, the frequent alternations of freezes and thaws in the winters of their latitude of occurrence, are even more disastrous, and cause a frequent freezing-out of winter grain, that at first sight seems very surprising. The effects of denudation on these soils are but too obvious even to the passer-by, are difficult to check, and are fast assuming the proportions of a public calamity.

These soils are easily tilled when in the proper condition, but if ploughed too wet are severely injured, hard clods remaining throughout the season. There readily forms on their surface a very hard crust (they "bake"), so that the surface requires stirring after every rain.

No. 173 is the subsoil of the Cretaceous prairies of Northeastern Mississippi, forming a stratum three to seven feet thick, overlying the Cretaceous rock. Although, in the wet condition, it is accounted a "heavy clay" soil, it possesses the peculiarity of "slaking" on drying, instead of forming a hard crust—unless,

* Miss. Rep., 1860, p. 197.

indeed, the drying process be exceedingly slow. It is not, therefore, as difficult to cultivate as would be supposed from the sum of its fine ingredients. Nor is it nearly as much subject to denudation as the two preceding soils, the mass formed by its contact with water being too tough and coherent to be readily moved by flowing water. But being very little pervious, it is liable to injury in wet seasons; while in dry ones, the cracks formed by the contraction of the subsoil prove disastrous.

No. 230 is the soil prevalent in the Flatwoods (see above), and is the direct result of the disintegration of the old Tertiary clays. It is a very heavy, intractable soil, yielding good crops only in very favorable years, as it is exceedingly liable to injury both from wet and dry seasons, and can be tilled only within a very limited range of condition as to moisture. Water will stagnate on it for weeks, and a late, wet spring will, sometimes, altogether prevent the pitching of crops. But it is not at all liable to denudation.

No. 246 is likewise the direct result of the disintegration of (highly ferruginous) Tertiary clays. Notwithstanding its high percentage of "clay," it is more easily tilled than the preceding one, although acquiring a stony hardness when dried slowly. The fact that among its 40·25 per cent of "clay" there are 10·6 of ferric oxide, and that it contains ·8 per cent of lime, explains both its easier tillage and greater thriftiness, as compared with the preceding. It is a pretty "safe" soil, and quite productive; not at all subject to denudation.

No. 196 is the extreme of a clay soil, so as to be almost unfit for tillage, and directly available for the potter's lathe. It bears, nevertheless, a pretty good growth of timber, chiefly pine. Its popular name is derived from the peculiar aspect assumed by its surface, when after a drought which has caused fissures (as much as an inch wide) to be formed, a rain causes the edges first to crumble off into the open cracks, and then swell; which, with the subsequent swelling of the mass itself, compels it to bulge up. The result is a hillocky surface, which is popularly likened to "hog wallows." The soil is, at present, practically worthless.

The next, No. 390, is very similar in its (ostensible) physical composition to the preceding. Yet while the "hog-wallow" soil is among the most worthless of the soils of Mississippi, this, the celebrated "buckshot" soil of the Mississippi bottom, is among the most valuable. True, the chemical composition of the buckshot soil is greatly superior to that of the other yet it could not rank as highly as it does, as a cotton soil especially, but for the fact that (in common with the prairie soil, 173, above described) it possesses the property of crumbling or

"slaking" by rapid drying; so that, even when it has been ploughed too wet, on drying each clod resolves itself into a pile of loose crumbs, which have given rise to the popular name of "buckshot." Notwithstanding its clayeyness, it is therefore a very "safe" soil, and highly esteemed for its thriftiness.

Alongside of this soil, which represents the cypress swamp deposits of the "Port Hudson" epoch of the Champlain period of depression, I give the composition of the "Loess" of the Lower Mississippi; a deposit evidently formed in a shallow, broad fresh-water estuary possessing a slight flow, during the time of more rapid depression of this portion of the continent. It forms a soil very easily tilled, somewhat too open and droughty, but fairly productive, and practically exempt from denudation.*

It is interesting to compare this ancient deposit with those now formed, under somewhat analogous circumstances, by the sluggish "bayous" traversing the bottom of the great river. Compare No. 237 with 377, a "Frontland" soil from a plantation on Indian bayou in Sunflower County, and we find the physical constituents almost identical. No. 395 is from a point near the main river, on Gov. Alcorn's plantation in Coahoma County; it has evidently been deposited by a more rapid current, as it contains more of the coarser ingredients, to which there adhered a sufficiency of clay to render the soil retentive, though so porous that water will not stand on it for a moment. It is very easily tilled, and from its great depth is very productive.

I subjoin, for farther comparison, the analysis of a specimen of river deposit, taken in the shallow water of the Southwest Pass of the Mississippi River, three miles below the Head of the Passes, at extreme low water. Here, again, the sediments of 1, 2, 4^{mm} form the prominent landmarks, as in the two other river deposit soils; in which the clay and finest silts seem to be the chief variables.

Having thus established, presumably, the normal composition of the river alluvium proper, I add, for farther comparison, the analysis of material from a stratified mudlump cone, which greatly resembles in aspect the river deposit. The point to be determined is whether this cone represents an upheaved mass of river deposit, or the mud ejected from a mudlump crater† —an eruption cone. The result seems to point to the latter as the more probable origin of the mass, as it presents but little similarity to the recognized river deposits, in the proportions of its sediments.

* Miss. Rep., 1860, p. 314.

† See my paper on the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi, Am. Jour. Sci., April, May and June, 1871.

In discussing the results of these analyses, I first recall to mind the practical object primarily intended to be subserved by them, viz: to convey to any intelligent mind, anywhere in the world, a definite idea of the physical qualities of the soil; of its tillability, so to speak; of its behavior in wet and dry seasons; its liability to washing, etc. If the data given in the table do not at present convey such definite knowledge to the minds of this audience, it is because the molecular properties of the several sediments are not yet fully known, nor generally understood. But there can be little difficulty in the empirical determination of these factors, once for all, so far as they refer to the pulverulent minerals, whose physical properties are sensibly dependent upon the size of the particles alone; the differences of specific gravity, etc., being ordinarily too slight to influence materially their modifying influence upon the clay, or upon each other. To this rule mica and bog ore form, probably, the only practically important exceptions.

As regards the modifying effect upon the extreme plastic properties of the clay, the pulverulent ingredients obviously divide into two chief classes, viz:

1. The coarse portion, which increases the "lightness" and porosity of the soil, sensibly in proportion to its percentage.

2. The fine portion, which, while modifying the plastic properties of the clay, yet renders the soil heavier in tillage than would be the case if it were absent, and the clay adherent to the coarse particles alone.

Soils consisting mainly of very fine siliceous silt, with only a small percentage of clay, are among the very heaviest, working "like putty," clogging the plough when in the least degree too wet, and in drying, caking into clods of "hardpan."

Such being the case, it would seem that between the coarse part which lightens soils, and the fine silts which, like clay, render them heavier, there must be a neutral point—a degree of fineness which will not sensibly influence either the porosity or the compactness of the soil. Odd as this conclusion appears, it seems nevertheless to be borne out by experience.

In fingering the coarser silts, it at once becomes obvious that nothing above 1^{mm} hydr. value can tend to render a soil heavier; while it is equally manifest that the impalpable particles belonging to the velocity of $0{\cdot}25^{mm}$ cannot tend to lighten. In searching tentatively, by the summation of groups of physical ingredients, for numbers that would satisfactorily express the estimated relative resistances to tillage of the soil analyzed, I found that such numbers would result from a summation of the three items lowest in the column, viz: the silts of 0·25, $<0{\cdot}25$, and clay. These are given under the head of "Compactness" or "Resistance to Tillage."

Similarly, numbers satisfactorily expressing the relative "Openness" result from the summation of the coarser ingredients, down to 1^{mm} inclusive. These numbers are given opposite to the heading "Porosity."

But either series becomes quite unsatisfactory, so soon as the silt corresponding to $0{\cdot}5^{mm}$ is added either way; except, of course, where its percentage is too small to influence either sum very seriously.

Of course these can only be approximations, it being especially obvious that sand of 64 and 32^{mm} must exert a much greater influence toward rendering a soil "open," than silts of 1 or 2^{mm}; which are, nevertheless, accounted for as equal in effect, in the above summation. Yet even here there are counterbalancing considerations, which in a measure explain the comparatively close approximation to the result of experience. Chief amongst these is, doubtless, the circumstance that the finer materials, when damp and stirred up (as they are in the cultivated soil), will occupy a much greater bulk than equal weights of coarse sand; being in what is technically termed a "woolly" condition of looseness. It is therefore quite intelligible that, within certain limits, "coarse silt" should exert a "lightening" influence equal to that of "coarse sand," which is apt to pack quite closely.

It may be asked, What would be the character of a soil consisting exclusively of the silt of $0{\cdot}5^{mm}$, claimed to be sensibly neutral in its effect on the compactness and porosity of soils? I reply that, judging from the small quantities of material at my command, such soil would offer an extremely slight resistance to tillage, and that such resistance would be increased by the addition of either clay or sand, in proportion to the amounts added.

The case, however, can hardly occur in nature. The difficulties encountered in separating the several materials in accordance with their hydraulic values, even by the aid of apparatus especially constructed for the purpose, forcibly suggests that it is scarcely possible that such conditions should ever be realized in nature: the tendency to coalescence of particles necessarily causing all sedimentary deposits to consist of molecular aggregates (at least so far as the finer portions are concerned), instead of simple granules. These aggregates will rarely, if ever, consist of particles of equal hydraulic value, the natural tendency being for small particles to fill up the interstices left between larger ones, which cannot attain close contact between themselves alone.* Moreover, in view of this inevitable formation

* There is a sensible difference, in this respect, between materials much rounded and water-worn, and those whose grains are still "sharp." The latter are much more difficult to separate in the churn elutriator, and re-coalesce most pertinaciously.

of aggregates, the molecular properties of a clay or subsoil will never correspond exactly to the mean resulting from a mere consideration of the molecular coefficients of each one, multiplied into its percentage. How far this difference extends, is a question involving a previous investigation of those coefficients.

Among the latter, that of absorption of aqueous vapor is of no mean importance, since it determines, in a great measure, the resistance of the soil to drought. As heretofore stated,* I find that at temperatures between +7° and +21°, the amount of aqueous vapor absorbed by a thin layer of a clay, or soil not unusually *rich in humus*, in a saturated atmosphere, is sensibly constant; the variations being within the limits of errors of observation, and indiscriminately either way. A glance at the data given in the table, opposite the heading "hygroscopic moisture," shows that while in general, as is well known, clay soils are more absorbent than sandy ones, yet there exists no direct numerical relation between the amount of clay present and the absorbing power. Not only is that of the typical white pipe-clay (No. 238) scarcely greater than that of an ordinary loam subsoil (Nos. 397 and 219), but it is not half as great as that of the clay soil 246 (with 40 per cent of "clay"), which in its turn has a higher absorptive coefficient than 196 (with 47 per cent of clay). Finally, 230, with 25·5 per cent of clay, is more than equal in hygroscopic power to the pipe-clay with 75 per cent.

Evidently, the hygroscopic coefficient is largely controlled by the presence, with the clay, of the powdery ingredients which determine its looseness of texture, so to speak; moreover, the finer silts themselves possess a considerable absorbing power. Again, the presence of hydrated ferric oxide materially influences this power; so much so that no general conclusion concerning the hygroscopic effect of "clay" can be reached, unless the amount of iron present be taken into account. I am unable, as yet, to furnish this datum for all the soils on the table, save as regards, for most of them, the percentage in the original substance. That the hydro-ferric oxide accumulates mainly in the "clay" obtained in silt analysis, I have already stated; and hence the percentages given at the bottom of the table may measurably serve to form an estimate of its influence on the hygroscopic properties. In some cases, however, the ferric oxide obtained in analysis was almost altogether present in the shape of bog-ore grains; these are placed in parentheses, it being obvious that the "white" soils, to which these determinations belong, do not contain exceeding 0·5 per cent of the oxide in the finely-divided, hygroscopically effective con-

* Proc. Am. Assoc. Adv. Science, Dubuque meeting, 1872, p. 73.

dition. In the coarse sandy soil 248, the iron mainly incrusts the sand grains; and in Nos. 165, 206 and 390, the presence of humus, in sensible quantities, influences the coefficient. In the rest, the amount of humus is insignificant, and the influence of the finely divided hydro-ferric oxide is especially noticeable when we compare Nos. 209 and 397 with each other; and also Nos. 230 and 196 with 246. The clay obtained in the silt analysis of No. 219 contains, according to Mr. Loughridge's determination,* 18·76 per cent of ferric oxide, as compared with 5·60 in the original substance; its absorptive coefficient was 20·0, as compared with 7·21 in the original. How much of this increase of hygroscopic power was due to the concentration of the clay alone, we can at present but conjecture; but if we may judge by the absorptive power of the pipe-clay 238, the increase must be largely attributed to the hydro-ferric oxide.

The influence of "humus" on the hygroscopic power is known to be very great; so also is that of the soils' porosity and resistance to tillage. Unfortunately, the very indefinite character of "humus" renders it extremely difficult to determine quantitatively its action, and take it into account.

The questions remaining to be determined in connection with this whole subject are so numerous, and so little explored as yet, that their full elucidation might well form the work of a lifetime.

ART. III.—*On the Distribution of Soil Ingredients among the Sediments obtained in Silt Analysis;* by R. H. LOUGHRIDGE, Assistant State Geologist of Mississippi.

IN connection with the separation of soils into sediments of definite hydraulic value, as accomplished by Dr. Hilgard's churn elutriator, an interesting question arises as to the chemical composition of the sediments obtained.

It is evident from his results that, in the soils treated, all of the important soil ingredients are contained in the finer sediments, there being visibly nothing but quartz sand of different diameters remaining in the coarser ones.

Does then the "clay" contain them all, or are they more or less distributed among the several proximate sediments?

In the investigation of this question, use was made of the same yellow loam upland subsoil, from Benton Co., Miss., that formed the subject of my experiments on "Strength of Acid and Time of Digestion." Great care was taken to obtain a

* See the succeeding paper.

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complete and pure sedimentation, distilled water being used; and the analyses were made, according to our usual method, after five days' digestion in acid of strength 1·115.

In the following table of results the percentages are given, first with reference to the absolute amount of each sediment itself; then with reference to the entire amount of soil taken for elutriation. In the last column a summation is made of each ingredient for comparison with a previous analysis of the soil, which is placed alongside.

Hydraulic Value, . . . CLAY.			<0·25 mm.		0·25 mm.		0·5 mm.		1·0 mm.		Other sediments	Total in sediments	Original soil.
Per Cent. in Soil, . . . 21·64.			29·56		12·54		19·67		15·11				
	A	B	A	B	A	B	A	B	A	B			
Insoluble residue,	15·96	4·35	73·17	17·29	87·96	11·03	94·13	12·72	96·52	12·74	13.76	71·89	70·53
Soluble silica,	33·10	7·17	9·95	2·34	4·27	·53	2·35	·32				10·36	12·30
Potash,	1·47	·32	·53	·12	·29	·04	·12	·01				·49	·63
Soda,	(1·70)		·24	·06	·28	·04	·21	·02				·12	·09
Lime,	·09	·03	·13	·03	·18	·02	·09	·01				·09	·27
Magnesia,	1·33	·29	·46	·11	·26	·03	·10	·01				·44	·45
Br. Ox. Manganese,	·30	·06	·00	·00	·00	·00	·00	·00		0·36		·06	·06
Ferric oxide,	18·76	4·06	4·76	1·11	2·34	·29	1·03	·14				5·60	5·11
Alumina,	18·19	3·97	4·32	1·04	2·64	·33	1·21	·17				5·51	8·09
Phosphoric acid,	·18	·04	·11	·02	·03	·00	·02	·00				·06	·21
Sulphuric acid,	·06	·01	·02	·01	·03	·00	·03	·00				·02	·02
Volatile matter,	9·00	1·33	5·61	1·43	1.72	·23	·92	·29				3·64	3·14
TOTAL,	100·14	21·64	99·30	23·56	100·00	12·54	100·21	13·67		13·10		98.28	100·63
Total Soluble matter,	75·18		20·52		10.32		5·16						
" " Bases,	41·84		10·44		5·99		2·76						
Soluble silica in crude substance,	·38	0·01											0·19

A. Calculated on the amount of Sediment. B. Calculated on the amount of Soil.

It appears from these analyses that the "clay" is by far the richest in mineral ingredients, the amount being more than

twice that of the others combined. Its insoluble residue is very small, while the soluble portion consists largely of free silica derived from hydrous silicates of the bases.

Its volatile matter (which includes hygroscopic moisture left after drying at 100° C., and water of hydration) is of course the largest; as are also the remaining ingredients, except lime. The large amount of soda, however, is due to the chloride used in the precipitation of the diffused clay.

In the other sediments, the soluble ingredients, except soda and lime, decrease in almost a geometrical ratio; there being also a corresponding increase of sand.

There are several interesting points in connection with this ratio of decrease which may be summed up as follows.

1. The iron and alumina exist in almost identical relative proportions in each sediment; making it probable that they are in some way definitely correlated.

2. Potash and magnesia also exist in almost the same quantities, and their ratio to each other in all the sediments being almost constant seems to indicate that they occur combined, perhaps in some zeolitic silicate, which may be a source of supply to plants.

3. Manganese exists only in the clay, a mere trace being found in the next sediment.

4. The lime appears to be "nowhere," having probably been largely dissolved, in the shape of carbonate, by the large quantity of water used in elutriation. Its increase in the coarser portions may be owing to its existence in the crystallized form, not so readily soluble.

In a general summation of the ingredients in the several sediments and comparison with the analysis of the soil *per se*, there is a loss in potash, magnesia and lime: which may reasonably be supposed to have been dissolved by the water of elutriation.

Some of the soluble silica clearly remains undetermined in the coarser sediments.

The differences in ferric oxide and alumina, shown throughout the analyses of this soil, may partly be accounted for by the unequal distribution of the particles of iron ore existing in the soil.

Of course the law of distribution of soil ingredients may differ in other soils; but the great distance from the point of derivation of the materials, and the wide distribution of the soils of which this is a type, probably render the above results of more than local applicability.

ART. IV.—*On the Influence of Strength of Acid and Time of Digestion in the Extraction of Soils;* by R. H. LOUGHRIDGE, of Oxford, Miss.

THE following investigation was undertaken with a view of determining the extent to which the variations likely to occur in the extraction of soils by hydrochloric acid, for the purpose of analysis, can influence the ultimate results; the special object being to ascertain the comparability of the analyses made in connection with the Agricultural Survey of Mississippi, both amongst themselves, and with those made by similar methods, by Dr. Peter, of soils collected by the Surveys of Kentucky and Arkansas.

In beginning the analyses of Mississippi soils in 1859, Dr. Hilgard adopted the following method, which has also been adhered to by his successors in this work, in over two hundred analyses made.

The soil (*i. e.*, "fine earth") is pulverized with a wooden pestle and thoroughly mixed. The hygroscopic moisture is determined, after exposing it in a space saturated with vapor, in a layer not exceeding 1^{mm} in thickness, for twelve hours, by drying at 200° C. in a paraffine bath. Of this dried substance from two to three grams are usually used in the general analysis, the methods employed being in general those adopted by Dr. Peter.* In another portion, after ignition, the phosphoric acid is determined by digestion for five days with nitric acid at 100° C., evaporation, precipitation by ammonium molybdate, digestion at 100°, solution in ammonia and precipitation by magnesium sulphate.

For general analysis the soil is digested in hydrochloric acid of strength 1·115 (as a rule) at 100°. It is then evaporated to complete dryness, this adding another day to the digestion.

In the insoluble residue the soluble silica is determined by boiling with sodic carbonate. The alumina and ferric oxide are precipitated according to Rose's method of boiling, for the complete separation of manganese, magnesium and calcium. The mixed precipitate is treated with potassic hydrate.

After precipitation of the lime by ammonic oxalate, the ammoniacal salts are destroyed by Lawrence Smith's method, with aqua regia; and the residue converted into nitrates, from which sulphuric acid is precipitated by barium nitrate. The alkalies are then separated by treatment with oxalic acid, ignition and washing. In the residue, barium, manganese and magnesium are separated as usual.

* Ky. Report, vol. iii.

With the aid of a Bunsen's filtering apparatus we can, by this method, complete an analysis in five days, exclusive of digestion; and three analyses may be in progress at the same time.

The substance experimented upon was a subsoil, a typical representative of the best yellow loam uplands of Mississippi, from the table lands of Benton Co., Miss.; No. 219 of the Survey Collection.*

To determine the question as to whether such variations in the *strength* of the acid, as might possibly have occurred in the use of the steam-distilled (i. e., from a retort surrounded by steam) product, without previously ascertaining its concentration, portions of the subsoil were digested five days with hydrochloric acid of the strength, severally, of 1·100, 1·115 (the normal concentration) and 1·160.

As to the *time* during which the soil must be digested in hydrochloric acid that the (sensible) limit of its solvent action upon the important soil ingredients may be reached, Dr. Peter's practice has been to digest for about ten days, in his 800 analyses of Kentucky and Arkansas soils; while for reasons of convenience, half that time has been adopted in the analyses of the Mississippi Survey. The question whether, under these circumstances, the two series can be deemed comparable, was approached by digestions, for periods of one, three, four, five and ten days, of the same soil with the same large excess of acid of 1·115; all precautions being taken to accomplish each analysis as nearly as possible under the same circumstances.

For the digestions, use was made of porcelain beakers (the use of glass being objectionable because of its solubility); the same amounts (40^{ccm}) of acid were used, and steam kept up about twelve hours each day.

The hour of "putting down" was carefully noted, and at the end of the allotted time the solution was poured off from the insoluble residue, and each evaporated to dryness separately and reunited in solution, to prevent any further action of the acid.

This result points to the conclusion, that while lime and magnesia (being readily dissolved) are probably present chiefly as carbonates or hydrocarbonates, potash as well as alumina, and to some extent lime, are present as silicates, and for that reason are not as fully extracted by acid of low strength as by that of 1·115; although the former acts more powerfully than that of 1 160

The latter fact (the coincident result of two analyses). though unlooked for, is not without analogies, although its precise

* The analysis of the subsoil of a neighboring tract is given in Hilgard's Report, 1860, p. 292.

cause, in this case, still requires elucidation. Whether the maximum of action is exerted by acid of 1·115, is another question of some interest, to be determined hereafter.

The results of the investigation as to strength of acid are as shown in the following table:

Ingredients.	Sp. Gr. of Acid.		
	1·10	1·115	1·160
Insoluble Residue,	71·88	70·53	74·15
Soluble Silica,	11·38	12·30	9·42
Potash,	·60	·63	·48
Soda,	·13	·09	·35
Lime,	·27	·27	·23
Magnesia,	·45	·45	·45
Br. Ox. Manganese,	·06	·06	·06
Ferric Oxide,	5·15	5·11	5·04
Alumina,	6·84	8·09	6·22
Sulphuric Acid,	·02	·02	·02
Volatile Matter,	3·14	3·14	3·14
	100·02	100·69	99·29
Amt. of Soluble Matter,	24·00	27·02	22·27
Amt. of Soluble Bases,	13·50	14·70	12·83

It thus appears that in the strongest acid the amount of insoluble residue is far greater than in either of the others, and that the difference lies chiefly in the soluble silica and alumina (i. e., clay), together with potash and lime. The other ingredients seem to be indifferent as to the strength of the acid.

Between the acids of strength 1·10 and 1·115 the difference is not so great, but the advantage is clearly with the latter, the amounts of silica, potash and alumina being greater, while the lime remains the same in both.

As for the comparability of the analyses as affected by the probable variations of strength of acid, I remark that the acid used for distillation by Dr. Peter, as Dr. Hilgard informs me, was the "C. P." of commerce, whose strength rarely much exceeds or falls below that of 1·115; while that used by us was usually the crude, diluted nearly to the same strength. The first and last portions coming over were habitually, I believe, rejected in either laboratory. Under these circumstances, it is very improbable that either of the extremes of sp. gr. above discussed ever actually occurred; especially as regards the stronger acid, which being in small quantity, would always be mixed with the succeeding weaker distillates.

It is therefore not probable that the percentage of potash or other important ingredients could have been so far underestimated in either of the series of analyses, as to seriously influence their comparability, either within themselves, or with each other.

The experiments on the influence of the time of digestion, made with acid of 1·115, resulted as follows:—

Ingredients.	No. of Days Digested.				
	1.	3.	4.	5.	10.
Insoluble residue,	76·97	72·66	71·86	70·53	71·79
Soluble Silica,	8·60	11·18	11·64	12·30	10·94
Potash,	·35	·44	·57	·63	·62
Soda,	·06	·06	·03	·09	·28
Lime,	·26	·29	·28	·27	·27
Magnesia,	·42	·44	·47	·45	·44
Br. ox. manganese,	·04	·06	·06	·06	·06
Ferric oxide,	4·77	5·01	5·43	5·11	4·85
Alumina,	5·15	7·38	7·07	7·88	7·16
Phosphoric acid,				·21	·21
Sulphuric acid,	·02	·02	·02	·02	·02
Volatile matter,	3·14	3·14	3·14	3·14	3·14
Total,	99·63	100·68	100·55	100·69	99·80
Amount of soluble matter.	19·67	24·88	25·57	27·02	24·87
" " " bases,	11·05	13·68	13·91	14·49	13·68

It thus appears, that the amount of dissolved ingredients increases up to the fifth day, the increase becoming, however, very slow as that limit is approached. It is also found that the ingredients offering the greatest resistance to this action are the same as those whose amounts were sensibly affected by the strength of acid, viz., silica, potash and alumina.*

In regard to lime and magnesia, one day's digestion not being sufficient for full extraction, it is evident that they do not exist in the soil as carbonates or hydric oxides only, as has been supposed; but also as silicates.

A comparison of the results of the five and ten day digestions shows that the solvent action of the acid has substantially ceased, there being no further increase of the amount of dissolved matter.

So far, therefore, as the time of digestion is concerned, the analyses of the Mississippi Survey are strictly comparable with those of Arkansas and Kentucky soils, made by Dr. Peter.

ART. V.—*On a new form of Cathetometer;* by WILLIAM GRUNOW.

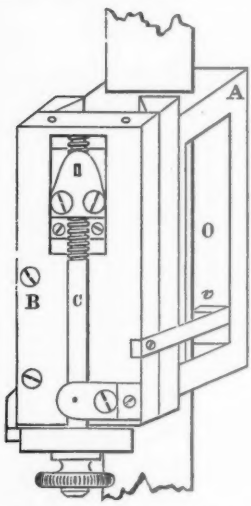
THE cathetometer consists essentially of a graduated vertical rod, on which slides a block supporting a leveling telescope. The block is commonly divided into two distinct pieces, both

* There is an apparent loss of alumina in the four days' digestion, owing to the lack of a second separation from iron, whose quantity is correspondingly increased.

sliding on the rod and placed over each other, one of them being provided with a clamp, and connected with its mate by a micrometer screw and spring, or by the former alone.

This form of fine adjustment seems to have been derived from that employed in the earlier compound microscopes, and though its manifest defects have long since caused its disuse with these instruments, it is still ordinarily employed in the construction of cathetometers.*

I have recently constructed, for the Physical Cabinet of Columbia College, a cathetometer, in which, by the use of another arrangement, great steadiness and accuracy of movement are attained, in combination with simplicity.



Upon a graduated, vertical, triangular brass bar, slides a *single* block, which carries the telescope and the micrometric arrangement for the fine adjustment. On one of the sides of this block, which is fastened in position by a thumbscrew, is dovetailed the slide B, which, being provided with adjusting screws, can be made to move steadily and accurately. The slide B is moved up and down the block A by the micrometer screw C, which is mounted in such a way that its motion cannot interfere with the steadiness of the movement of the slide B; it can also be adjusted so that it works without dead motion.

Each turn of the screw corresponds with one division of the graduated bar on which the block A slides. The slide B carries an arm with an index v, which moves in an opening O, cut out in the side of the block A corresponding to the graduation on the bar. The screw carries a movable head, divided into one hundred parts, and by means of its index, fractions of a turn of the screw or rather fraction of one division on the bar, can be read off easily and accurately. The leveling telescope is screwed on the top of the slide B.

* Compare Leçons de Physique, par M. P. Desains, vol. i, p. 12; Die Physik auf Grundlage der Erfahrung, von Dr. Alb. Mousson. 2d ed., vol. i, p. 15; Lehrbuch der Physik und Meteorologie, von Dr. Joh. Müller, 6th ed., vol. ii, p. 569; Lehrbuch der Experimental Physik, von Dr. A. Wülner, vol. i, p. 43; Cours de Physique, par M. J. Jamin, 2d ed., vol. i, p. 36; Elementary Treatise on Natural Philosophy, American ed., p. 130, by A. P. Deschanel; and Allgemeine Encyklopaedie der Physik, 1 Band, p. 548.

The screw which I used for this instrument had a millimeter thread, and its head being divided into a hundred parts, gave hundredths of a millimeter.

In testing the instrument with the higher power, I felt gratified that measurements could actually be made to the hundredth part of a millimeter, and confirmed by repetition.

To make the instrument more generally useful, the objective of the telescope is provided with a draw-tube which adds four inches to its length, and permits observations to be taken at as short a distance as three or four feet. In addition, it is provided with a brass cap, which can be slipped over the mounting of the objective, and which carries a supplementary centered achromatic lens, which permits the instrument to be approached to within a distance of six inches from the object. When thus arranged it enlarges the actual dimensions of objects about forty diameters, but even with this rather high power, the smoothness and steadiness of the micrometric movement seems in no degree impaired.

Columbia College, Nov. 4th, 1873.

ART. VI.—*Notes on the Geology of Western Texas, near the thirty-second parallel;* by WALTER P. JENNEY, E.M., Geologist Texas and Pacific Railroad Survey in West Texas.

I. *On the occurrence of a remarkable Lower Silurian Section in the Organ Mountains.*

WHILE examining the mountains about two miles north of El Paso, Texas, which are a continuation of the Organ range southward from Solidad Pass, I was surprised to find a great development of the Paleozoic rocks, with the divisions between the strata of the different periods very distinctly marked, and each bed filled with an abundance of well-preserved specimens of its characteristic fossils.

The strata dip at an angle of about 20° to the west, toward the valley of the Rio Grande; and the upturned edges of the different beds form the eastern slope of the range, where, beginning at the foot hills at the base of the mountain, the section is as follows:

A. A coarsely crystallized red-feldspar granite, which extends along the whole length of the eastern base of the range, and where exposed has a thickness of 100 feet or more.

B. Gray quartzite, resting unconformably on the granite: the lower portion of this stratum is hard and compact, and contains some chlorite slate, but it merges as one ascends into a

calcareous sandstone full of the borings in pairs of the *Scolithus linearis* of the Potsdam sandstone. The total thickness of this bed is about 250 feet.

C. Gray crystalline limestone, nearly 250 feet in thickness, resting conformably on the sandstone: in the lower part of the bed no fossils were found, but in the upper layers one or two species allied to *Archæocyathus* are abundant, which indicate its equivalence with the Calciferous sandrock. A few feet of sandstone weathering dark red separates this bed from the next in the series.

D. Gray magnesian limestone, about 450 feet in thickness, and containing much flint or hornstone; its characteristic fossils are a Receptaculite, and shells allied to *Orthoceras* and *Helicotoma*. On more extended examination, this bed may be identified as Chazy.

E. A black limestone, nearly 100 feet in thickness, forming the crest of the range: it rests conformably on bed D, and the contact is very distinctly marked. The black limestone is filled with well known fossils of the Trenton period, including *Maclurea magna*, species of *Orthis*, *Orthoceras*, *Cyrtoceras*, and corals allied to *Halysites* and *Syringopora*.

Passing over the top of the mountain and descending on the western slope, the next stratum in the series encountered rests on the Trenton limestone; but it contains forms of life which are totally different though no less abundant.

F. Gray limestone, which has been very much denuded, yet not less than 200 feet in thickness remains; in the lower part of the bed *Halysites gracilis*, species of *Syringopora*, *Zaphrentis* and several other corals, together with *Rhynchonella increbescens* were found, and in the upper part many varieties of Brachiopods, among which were *Strophomena rugosa*, species of *Leptæna* and several of *Orthis*, which identify it with the Hudson period.

G. A coarse conglomerate, composed of rounded and angular fragments of the Trenton and Hudson limestones cemented together by carbonate of lime and sand: it is of varying thickness, being in some places 60 feet thick and in others entirely wanting in the series. It rests unconformably on both the Trenton and Hudson beds, and seems to contain no fossils; but from its position it may possibly be equivalent to the Oneida conglomerate of New York.

H. A ridge of light gray crystalline limestone extends along the western base, parallel to the crest of the range, and rests unconformably on the conglomerate and the Trenton and Hudson beds: its thickness is about 400 feet, and the dip is only 10° to the west. These facts show that it was deposited after a partial uplifting of the underlying beds, and that subsequently

the range has attained its present elevation. Owing to the crystalline character of the limestone, nearly all traces of life are destroyed; but a few fragments of imperfect shells resembling a *Pentameras* were found near the contact with the conglomerate, so that the lower portion of this bed may be of Niagara age: but the resemblance of the limestone of the upper part of this ridge to that of Carboniferous age in the parallel range of the Hueco Mountains leads me to think that, on a more extensive examination, it will be found to be equivalent to it.

Dr. G. G. Shumard seems to have examined this same range, but at a point farther north. He mentions the occurrence of a limestone of Trenton and Hudson age succeeded by the Carboniferous. (Dana, Manual of Geology, p. 245.)

About two miles west of this locality, on the banks of the Rio Grande, are very interesting beds of Cretaceous age, through which the river has cut its present channel. These beds have been described in the reports of the survey of the Mexican Boundary.

In the parallel range of the Hueco Mountains, 20 miles east of El Paso, the section is similar but less distinctly defined: the dip of the strata is to the east, so that the upturned edges of the beds in the two ranges face each other.

A limestone of Carboniferous age forms the crest of the Hueco range, and rests on a magnesian limestone containing many fossils of the *Orthis* family, resembling Hudson or Niagara forms; but, though a careful search was made at the contact of the Silurian and Carboniferous limestones in the Organ, Hueco and Guadaloupe Mountains, no strata containing any Devonian forms of life were found. It appears, therefore, that the greater portion of the Upper Silurian and the whole of the Devonian periods are unrepresented in the rocks of Western Texas.

An immense development of Carboniferous strata occurs in the Sacramento and Guadaloupe Mountains, between the Pécos and Rio Grande; at Guadaloupe Pass, about 800 feet of sandstone underlie a precipice nearly 600 feet high of Carboniferous limestone, above which the peaks of the mountain rise to perhaps an equal height.

At the banks of Los Cornudos, seventy miles east of El Paso, a water-worn mass of syenite, covering nearly a square mile of area, rises from the plains to a height of several hundred feet: resting against its base is a limestone of Carboniferous age, containing several species of *Productus;* the limestone has filled crevices a foot in width in the syenite, in which several small spiral shells, species of *Pleurotomaria* and *Helicotoma* were found. As there are no indications of limestone having ever been deposited except near the base of the Cornudos, a portion of this rock may have been above water in the Carboniferous sea.

II. *The Llano Estacado, or Staked Plains.*

A great deal has been written about this desert, which stretches north and south nearly 350 miles, and, from the head waters of the Rio Colorado and its branches westward, from 50 to 150 miles, to the Rio Pécos. Its underlying strata were announced to be Triassic and Jurassic by Jules Marcou, but are now well known to be of Cretaceous age. A fine section of the Llano is exposed at Castle Cañon, near Horsehead Crossing of the Pécos: the strata, beginning at the base, are arranged as follows:

1. A coarse red sandstone without fossils, but probably of Triassic age, 50 feet exposed.
2. Soft calcareous brown sandstone, with fragments of fossil shells: this bed is 50 feet in thickness and probably of Cretaceous age.
3. Soft yellow limestone, 450 feet in thickness, containing an abundance of well known Cretaceous fossils, including *Gryphea Pitcheri*, *Exogyra Texana*, *E. Arietina*, *Arcopagea Texana*, *Ammonites Pedernalis*, and several species of *Cardium*, *Nerinæa* and *Pecten*.
4. Compact yellow limestone, 30 or more feet in thickness, wanting at Castle Cañon, but forming the tops of the highest hills on the Llano, and also found on the tops of the mountains in Jones County.

The characteristic fossil of this bed is the *Caprina crassifibra*, which is very abundant; the bed is, I think, equivalent to the "Caprina limestone" of Shumard, and is the most recent member of the Cretaceous in Western Texas. The Cretaceous beds on the banks of the Rio Grande, at El Paso, contain fossils identical with those from bed 3. Similar sections to that of the Llano were found at Fort Chadbourne, in the neighboring mountains, which were identical both in the arrangement of the strata and in the fossils from the different beds.

In Mason County, underneath the limestone and red sandstone, there is a metamorphic sandstone resting unconformably on micaceous gneiss. The hardness of the upper layers of limestone has greatly protected this formation from denudation, and given the "mesa" character to the hills, as the bedding is almost horizontal; but there can be no doubt that formerly this formation was much more extensive, and that the flat-topped hills and ranges of low mountains which are found east of the plains, almost as far as Austin, were islands in the sea which produced the denudation, their tops showing no evidence of having ever been submerged, and in some places wave-worn cavities extend at the same height along their sides.

ART. VII.—*On the Formation of the Lignite Beds of the Rocky Mountain region*; by L. LESQUEREUX.

FROM a report which is apparently reliable, but which I have not seen in print yet, a prominent geologist has advanced the opinion that the so-called lignite beds of the Rocky Mountains have been formed by the heaping of drifted materials. This opinion, says my informant, is sustained by the following facts:

1st. That the lignite beds are of too small extent, or cover too limited areas, to have been formed otherwise than by the heaping of materials carried into small basins.

2d. That the *under clays* of the lignite beds have no roots.

I do not wish, of course, to review the old hypothesis on the formation of coal and lignite, as exposed in a masterly manner and sustained by Bischoff; but only to answer the two above objections.

1st. It is evident, from all that has been ascertained of the lignitic basin of Clear and Boulder Creeks, by Hayden, Hodge and myself, that this productive lignite basin extends from the South Platte to Cheyenne, a distance in a direct line of more than one hundred miles. The width of this basin is not ascertained; but lignite beds have been found in borings thirty miles east of the mountains, or those of Golden and Boulder City. As yet, it is not positively known whether a continuous bed of lignite occupies the whole area; for this basin has from eight to sixteen beds in its whole thickness. This, however, I have seen this year. The main coal of Golden is continued south to Clear Creek, and has been tested all along for a distance of nine miles; and northward the same bed is recognized continuously for seventeen miles to north of Boulder Creek, where it is covered by conglomerate beds. This is extensive enough, I think, for a bed of lignite measuring generally from eight to fourteen feet in thickness. The lignite beds have been cut through by prodigious denudations. They have also been destroyed at many places, either partially or entirely, by combustion. The country around Black Butte, and from this place to Green River, is covered by hills, often composed of baked red shale or sandstone, etc., all changed by heat or by the combustion of beds of lignite. Local occurrences of this kind have considerably and locally reduced in extent the area of strata of combustible materials, and broken their continuity. The large or thick main coal of Black Butte has been destroyed in this way on its eastern side; and here its shale and sandstone are metamorphic, or as hard as steel, while on the other side, where the coal has been preserved, they have their natural softer composi-

tion. But even if the lignite beds were proved to be of little horizontal extent, this would be no objection against the supposition of their origin as peat deposits. The emerged peat formations are generally of this kind. It is indeed the general case that peat bogs now cover hollows of limited areas rather than wide surfaces. The peat bogs formed in water along the shores of lakes or near the mouths of great rivers, are only occasionally of wide extent. The deep peat bogs of Germany, Denmark and Scandinavia, where wood is found heaped by the growth of successive forests to the depth of seventy to one hundred feet, are mostly deposits covering from one to ten acres of ground.

2d. I can say, from repeated and personal observations, that most of the lignite beds of the west which have passed under my examination have the under clays full of rootlets or of roots of the floating plants which were the first, generally at least, to contribute to the formation of the bed of combustible material by their debris. At the Raton Mountains, at Cañon City, at Gehrung's near Colorado, at Golden, Marshall, Black Butte, etc., the coal is everywhere underlaid by chocolate-colored shale, often a compound of these roots or rootlets, so compact indeed that they cannot be determined, nor their forms distinctly recognized. I have for this reason collected many specimens for microscopical examination. Of course, the under-shales do not contain any roots (true roots of trees); the coal of the Carboniferous, too, never has any; for the good reason that trees do not grow in water, and that they only invade peat bogs when the ground is solid enough to support them. And even then the roots grow horizontally, and do not descend deep into the matter, which, generally impregnated by water, is to a degree inaccessible to atmospheric influence. The so-called roots of the clay beds of the Carboniferous measures, or the *Stigmaria*, are not roots but floating leaves. And even their cylindrical stems are rarely found in clay beds; only their leaves fill them, just as the radicles of water plants fill the clay of the Tertiary lignite. It is, however, a fact that some of the lignite clay beds, and those of the Coal-measures too, are clean or without admixture of vegetable remains, even of rootlets. But, when the peat is beginning its growth at the surface of a somewhat deep basin of water, whose bottom has been rendered impermeable by the deposit of clay (which always precedes the deposit of woody materials), this surface peat is often thick and compact before it is forced down and comes in contact with the clay; and in that case, therefore, the clay is pure or is not penetrated by roots or rootlets.

The theory of formation by drifted matter cannot give an explanation of this fact: that the bottom clay is perfectly

distinct from the coal or lignite matter, at the point of its surface where it is touched or overlaid by coal or lignite. There is no insensible transition from bottom clay to coal. Bischoff, as is well known, explained the differences in coal (pure as it is, indicating only a proportion of ashes equal to that of the wood) by supposing that after being drifted into a comparatively quiet basin of water, the heaviest particles of matter, sand and mud, had been first washed down to the bottom, and that the woody fiber, rather lighter, had been deposited afterward. In this case, the heaping of the matter would, of necessity, show a gradual transition in ascending, still higher up, from clay beds to clay and woody filaments mixed together, these successively becoming less impure. The heaviest coal should, therefore, always be at the bottom, the pure woody matter at the top. Who has seen in our lignite beds or coal beds anything like this? But of this hypothesis it is useless to speak further. It is set aside by facts and considerations a review of which would fill a volume.

There are of course some beds of impure lignite, whose origin is due to drifted wood, especially along large rivers. One is known at the mouth of the Rhone in France. I have seen some deposits of the kind in southeastern Arkansas, near the Washita River. The great Red River obstructions may become in time lignite deposits. But all formations of this kind show their origin by their composition: sand mixed with carbonized matter, sandy bottom, perforated too in various directions by drifted stems, etc. Nothing of this kind has been observed in the beds of lignite of the west, at least not in those which have come under my examination.

Columbus, Ohio, Nov. 16, 1873.

Art. VIII.—*On remains of Land Plants in the Lower Silurian;* by Leo. Lesquereux.

From a recent discovery, it now seems that traces of land vegetation exist in the Lower Silurian strata of this country. A few months ago, I received from Rev. H. Herzer* two specimens representing branches or small stems of a species referable to *Sigillaria*, and reported to have been found by Dr. S. S. Scoville on Longstreet Creek, near Lebanon, Ohio, in clay beds positively referable to the Cincinnati group of the Lower Silurian. The discovery of the remains of land plants in this for-

* Well known through the discovery of some remarkable animal and vegetable remains in the Devonian of Ohio.

mation is too remarkable a fact to be accepted without positive evidence. Being at that time about to take the field for geological explorations, I merely took a sketch of the specimens and returned them to the owner, purposing to examine more closely into the matter at a future time, either by going to Lebanon or by corresponding with Dr. Scoville. On my return, as Rev. Mr. Herzer had parted with the specimens, I sent to Dr. Scoville a sketch of the fossil under consideration, in order that he might recognize it, if it had been in his hands, and with the request to positively state whether he himself found the specimens, and when, and whether he had any more of the same kind. In his answer he writes: "I can say now most emphatically, that I found in Longstreet Creek, about six miles east of Lebanon, a fossil which resembles the sketch accompanying your letter in all the essential features. The specimen was, I think, in two pieces, or perhaps Mr. Herzer took only one piece. I know within a rod or two where it was found. Its position or horizon, in the Lebanon beds, was about the middle. Should any one question the accuracy of my statement in regard to the discovery of a specimen of this character, in the locality designated, I would refer them to Mr. S. R. O'Neall of this place, who has paid much attention to geology, and who will support my assertion, so far, at least, as to say: that I have described to him several times, and even but a few days since, the specimens under consideration."—In a postscript to this letter, Mr. O'Neall confirms the statement in regard to the specimens in question.

There can be therefore no doubt as to the locality where these vegetable remains have been found, or the geological age of the strata. The clays of the Lebanon beds are full of Trilobites of the same species that abound in the clay beds at the base of the Cincinnati group—*Calymene senaria*. The only question to be settled is the true character of the plant which the specimens represent.

As I have said above, there were two fragments of small stems or branches, referable to the same kind of vegetable; one, more complete, about two inches thick, cylindrical, the whole substance transformed into soft gray clay, the bark, or the outer surface only, distinctly moulded into clay, as is generally the case in specimens of this kind, and marked by rhomboidal, continuous, enlarged bolsters, surrounding the stem in a spiral, bearing at the middle a small oval or rhomboidal scar, less distinct, however, though well recognizable, and presenting the characters of stems of *Sigillaria Serlii* Brgt. or *S. Menardi* Brgt. The study of the specimens, as far as I was able to do it, left me undecided only in regard to their positive reference to the one or the other of these two species, on account of the somewhat

obscure form of the internal scars. Though the Cincinnati group has remains of Fucoids of large size, none has, as yet, been found there to my knowledge, as large as these stems. And the peculiar form of the bolsters, placed in spiral around the stem, similar in form, equal in size, regularly convex, preclude the supposition that the remains represent some new kind of marine plants, or are attributable to a concretionary structure. We have therefore to admit them as representative of land plants, and thus to recognize the existence of traces of land vegetation in the Lower Silurian, the lower part of the Cincinnati group being the equivalent of the Trenton group of New York *

This discovery is the more remarkable since we have, as yet, no records of vegetable remains from the Silurian of North America, except fragments of stems and rhizomes of *Psilophyton*, observed by Dawson in the Gaspé group of Canada. On these, Dr. Dawson remarks :† "Accordingly, it is in Gaspé that as yet we have the only link of connection of the Erian (Devonian) flora with that of the Silurian period. In the marine limestone of Cape Gaspé, holding shells and corals of Lower Helderberg age, along with some indeterminable plants, probably Fucoids, we have, as already stated, fragmental stems and distinct rhizomes of *Psilophyton*, some of them showing the scalariform axis well preserved. These fragments must have been drifted from the land; and, as in the immediately succeeding Lower Devonian beds, *Psilophyton* is associated with *Prototaxites*, *Arthrostigma* and *Calamites*, but is the most abundant of the whole, it is not unlikely that in the Upper Silurian land, it was associated with plants of these genera." In Europe too, the first remains of land plants have been found in the Lower Devonian, and as yet only a single specimen of a *Sigillaria*, described by Göppert as *S. Hausmannana*.‡ It was found as early as 1806, by Hausmann, during his geological exploration of Scandinavia, in a red Devonian quartzite just above strata of the Upper Silurian, where *Favosites polymorpha* was identified. Göppert, from whom these details are quoted, remarks that, on account of the presence of this species of *Favosites*, Murchinson admitted these strata to be Lower Devonian.

With the exception of the Lebanon specimen, the geological

* The occurrence of vegetable remains in clay beds abounding in remains of Trilobites is not subject to objection. The Coal-measures of the West have strata of shale, clay, limestone, even sandstone, where animal and vegetable remains are found together in abundance. I have found Trilobites in the shale overlaying coal beds at Summit Portage, Pennsylvania, with *Sigillaria*, *Stigmaria*, etc., and species of the same kind of animals, with plants too, in sandy clay beds of the upper Coal-measures of Indiana.

† Fossil plants of the Devonian and Upper Silurian formations of Canada, Pamphlet, 1871, p. 78.

‡ Flora der Silurischen, der Devonishen, etc., oder des sogenanten Uebergangsgebirges, p. 543.

formations of the United States have not afforded as yet any records of land plants earlier than those of the Lower Devonian. In Ohio and Kentucky, vegetable remains of this kind have been found at different places, mostly in concretions, including trunks or fragments of wood representing species of Conifers of the section of the *Araucariæ*, together with Lycopodiaceous plants; *Stigmaria*, *Sigillaria* and *Lepidodendron*. In Pennsylvania, a *Lepidodendron*, *L. primævum* Rogers, and a *Sigillaria* have been obtained from the same horizon. These fragments are as yet rare, and have not been satisfactorily determined, on account of the imperfect character of the specimens, mostly petrified pieces of wood, whose structure is studied with difficulty. It is certain, however, that in the Middle Devonian we have representatives of three distinct groups of vegetables: the Cellular Cryptogams, in a quantity of marine plants, the Vascular Cryptogams, in Lycopodiaceous plants: *Lepidodendron*, *Sigillaria*, etc., and the Phænogamous Gymnosperms, in the *Conifers*.

ART. IX.—*On a Combination of Silver Chloride with Mercuric Iodide;* by M. CAREY LEA, Philadelphia.

IN the course of an extended examination of the compounds formed by mercuric iodide, I some time since obtained two which I believed to be new. After having studied their properties, I found that one of them, a compound of the iodides of silver and of mercury, had previously been obtained by Meusel. I shall therefore here describe only the compound which mercuric iodide forms with silver chloride.

If to a portion of recently precipitated and still moist silver chloride, a considerably less quantity of mercuric iodide, also freshly precipitated and still moist, be added, we shall find that, after stirring them thoroughly together, the scarlet color of the mercuric salt is still plainly visible through the mass, which is of a bright salmon color. By standing some hours or a day, a remarkable change takes place, the red color wholly disappears and the powder became pure lemon-yellow. Before this change took place, the separate particles of the mercuric iodide could be plainly distinguished with a lens; after it, the powder becomes perfectly homogeneous. Fresh portions of mercuric iodide added, gradually disappear in the same way, until an equivalent quantity has been used.

A better plan, however, for preparing the substance consists in adding to a solution of a weighed quantity of potassic iodide an exactly equivalent quantity of mercuric chloride, and then, after thoroughly agitating and allowing the precipitate to fall, adding

an equivalent quantity of silver nitrate, also in solution. The potassic chloride formed by the first reaction is exactly sufficient to throw down the whole of the silver as chloride. When the silver salt is added, one may remark three precipitates visible in the liquid, irregularly blended, scarlet mercuric iodide, white silver chloride and the yellow substance resulting from their combination. The precipitates are then to be thoroughly stirred together to promote combination, which, however, is not complete for about twenty-four hours. Meantime the mixture is salmon colored from the presence of free mercuric iodide.

Obtained in this way, the substance appears as a heavy yellow powder, wholly free from any trace of red, and rather inclining to a greenish or lemon-yellow. This color it always exhibits, no matter how prepared, while still wet, even if left for weeks. Mixed, however, with gum arabic and spread on card-board, it dries to a full chrome yellow. It could not be obtained in a condition sufficiently pure for analysis, but there can be little doubt that its constitution is AgClHgI.

The new substance exhibits remarkable properties with respect to heat. Even below 100° F. it begins to redden, and this change rapidly increases with the rising temperature until it reaches a maximum at about 140° F. At this temperature it has a bright scarlet color, differing, however, a good deal from that of mercuric iodide, and more resembling, if moist, that of chrome red; if dry, that of vermilion. As the temperature falls again, the pale yellow color returns. A striking experiment consists in placing a portion of the substance in a test tube under water, and warming it at a Bunsen's burner. The very instant that the flame touches the glass, the whole layer of substance in contact with it flashes to a bright red. If heated till it is changed throughout, a portion taken out with spatula and dropped on a cold porcelain dish, becomes yellow at the instant of contact.

If a portion of the substance be mixed with a solution of gum arabic and be spread on card-board, it exhibits the following properties:

Warmed gently at a lamp (best by holding it near the glass chimney of an Argand burner), it assumes a deep red color; then, when removed, it recovers its yellow shade. Both changes take place so rapidly that the alteration of color may be watched, and is complete in a few seconds or half a minute. If instead of gently warming, a strong heat be applied, just below what is sufficient to char the card, the portion thus strongly heated assumes a still deeper color, and returns to the yellow much more slowly, retaining an intermediate orange shade for some hours. This change is brought about by a sudden and momentary heat: if the heat be continued, the mercuric iodide

volatilizes, and the portion so treated becomes permanently yellow.

If one of these cards be exposed to sunlight with a portion perfectly protected, the exposed part becomes slightly darkened. This effect takes place with an exposure of half an hour or less and is scarcely increased if the exposure be prolonged for many hours. By keeping for a few days in the dark, the deepening of color gradually fades out until the exposed parts are not to be distinguished from the rest. This effect may be repeated several times with the same card.

In reference to the compound of silver iodide with mercuric iodide, I feel constrained to differ from Meusel, who considers it only a mixture and not a combination. I take it to be a compound, though an extremely loose one, and for the following reasons, which apply equally to the silver chloride compound.

So long as the substances are only mixed, and before they have united, the characteristic color of the mercuric iodide is always conspicuously observable, and no mechanical mixing, however thorough, is capable of concealing it. The eventual disappearance of this color seems to be a proof of combination. This view is farther strengthened by what takes place in the case of *silver bromide*. When HgI is placed in contact with AgBr, no combination takes place as in the case of AgCl and AgI under similar conditions. Even after many days the color of the mercuric salt is conspicuously visible. In one case I kept HgI in contact with excess of AgBr, both freshly precipitated, for several weeks under water, at the end of which time the particles of HgI could be distinguished under a lens with perfect facility. At the end of weeks, the mixture of AgBr and HgI retains exactly the appearance which it presents when first mixed (supposing, of course, that it has been protected from the light). AgCl and AgI, when mixed with HgI, present at first the same appearance, which, however, subsequently changes completely, and a substance with new properties is the result. This seems clearly to indicate a combination.

The striking fact that the thermochromic properties of mercuric iodide are inverted in the new compound, which passes from yellow to red by heat, instead of from red to yellow, and the far greater sensitiveness to heat of the new substance, are strong arguments of combination.

Meusel's explanation of the change of color, in his view of mere mechanical mixture, makes it depend on a diminished power of absorbing red rays when warmed, which he ascribes to silver iodide. But the experiment which I have described with the substance spread on card-board disproves this explanation in two distinct manners.

At a temperature about 30° or 40° of Fahrenheit above the

boiling point of water, mercuric iodide becomes yellow. If, therefore, the new substances were mere mixtures on being heated to that temperature the red color previously acquired should disappear completely, since there could be no possible cause for its continuance. The mere mechanical mixture of two yellow substances (in the case of AgI and HgI), or of a white and a yellow (in the case of AgCl and HgI), could by no possibility produce a red one. This single argument would seem to be sufficient in itself.

The peculiar persistency, after applying momentarily a high heat, seems also inconsistent with the hypothesis of a mechanical mixture. Let us follow the phenomena which present themselves and consider them in the light of this hypothesis of a mechanical mixture. The substance is at ordinary temperatures yellow; it is difficult to suppose that white and scarlet mechanically mixed can form yellow. At 140° F., it is deep red; now this rise of temperature makes no visible change in the color of either constituent, taken separately; if the mixture be merely mechanical, it is difficult to see why the color should change. At a still higher temperature, let us say for example 300° F., mercuric iodide is yellow, but the substance in question is deep red. And, whereas before we had white and red mechanically mixed forming yellow, now we have white and yellow forming red. Even the phenomena of persistence are reversed, for whilst mercuric iodide after cooling retains for a time its yellow color, and then passes to its normal red, this substance, after a strong momentary heating, retains for sometime after cooling its red shade, and eventually recovers its normal yellow.

These properties seem to be irreconcileable with the view of mechanical mixture. The behavior of the substance when exposed to sunlight also affords a strong argument. The very faint darkening caused, and the gradual recovery of the original color, seem inconsistent with the hypothesis of the presence of free silver chloride. There is no doubt that the combination is a loose one. By repeated boiling with a considerable quantity of water, most of the mercuric iodide can be dissolved out, and this may be still more easily done with alcohol, in which mercuric iodide is more soluble than in water. This, however, is, of course, no proof of absence of combination, as many compounds can be broken up in a similar way. Even after repeated boiling with water, a portion of the mercuric iodide is held back, and it is curious that the abstraction of the mercuric salt does not change the color of the residue. The silver chloride does not recover its whiteness, the yellow color remains unchanged, but the property of reddening by heat disappears with the removal of the mercuric iodide.

426 Walnut st., Philadelphia, Dec. 5.

ART. X.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XXVI. *Results of recent Dredging Expeditions on the Coast of New England.* No. 4; by A. E. VERRILL.

(Continued from vol. vi, page 435.)

VERY few localities of "hard" bottom were met with in more than 25 fathoms of water; and consequently we could not obtain so complete a knowledge of the fauna occupying such bottoms, at greater depths off that coast, as of that inhabiting the soft muddy bottoms. This has, however, been remedied to a considerable extent by some of the subsequent dredgings made by Dr. Packard, when on the Bache. Moreover, a considerable number of species belonging properly on rocky bottoms came up attached to the boulders, already referred to, which we frequently brought up even from the softest mud.

Other inhabitants of such bottoms were obtained from the stomachs of fishes, freshly caught. From these and other sources we could now compile a pretty full list of species belonging to the hard bottoms in depths between 50 and 125 fathoms, off the coast between Cape Cod and Mount Desert.

Two of our dredgings off Seguin Island, in 33 and 45 fathoms respectively, belong to the series of outer and deeper dredgings, rather than among those made in the bays. They are, however, somewhat intermediate in character.

The first named locality was unusually rich in species, and I therefore give the entire list obtained at that place, so far as they have been identified. The bottom was generally hard, and in places rocky, but some patches of mud were evidently encountered by the dredge, and consequently there is a considerable number of true mud-dwelling species in the list. Only one haul of the dredge was made at this locality, owing to unfavorable weather.

Contents of a single haul of the dredge made Aug. 13, 1873, *on hard bottom, with some spots of mud, in* 33 *fathoms; locality, six miles east of Seguin Island.*

ARTICULATA.

Arachnida.

Nymphon, sp.

Crustacea.

Hyas coarctatus.	Hippolyte spina.	Metopa, sp.
Eupagurus Kroyeri.	Unciola irrorata.	Caprella, sp.
Pandalus annulicornis.	Cerapus rubricornis.	Praniza cerina.
Hippolyte pusiola.	Monoculodes, sp.	

Annelids.

Harmothoë imbricata.
Nicomache lumbricalis.
Nothria conchilega.
Phyllodoce catenula V.
Lumbriconereis fragilis.
Anthostoma acutum V.
Gattiola, sp.
Nereis pelagica.
Amphitrite Grœnlandica.
Cistenides granulatus.
Ampharete gracilis.
Ampharete, sp.
Vermilia serrula.
Arenia, sp.
Ninoë nigripes V.
Melinna cristata.
Thelepus cincinnatus.
Scione lobata.
Chone, sp.
Potamilla oculifera.
Sabella, sp.
Spirorbis lucidus.

Sipunculoids.

Phascolosoma cœmentarium.
Phascolosoma tubicola V.

Nemerteans.

Nemertes affinis.

MOLLUSCA.

Gastropods.

Admete viridula.
Bela turricula.
Bela harpularia.
Bela violacea.
Buccinum undatum.
Neptunea decemcostata.
Neptunella pygmæa.
Astyris zonalis V.
Trichotropis borealis.
Aporrhais occidentalis.
Velutina haliotoidea.
Lamellaria perspicua.
Lunatia Grœnlandica.
Turritella erosa.
Lepeta cæca.
Calliostoma occidentale.
Margarita cinerea.
Diadora noachina.
Doris planulata.
Hanleia mendicaria Carp.
Entalis striolata.

Lamellibranchs.

Saxicava arctica.
Macoma sabulosa.
Cardium Islandicum.
Cardium pinnulatum.
Cyprina Islandica.
Astarte undata.
Astarte elliptica.
Astarte lens.
Cyclocardia borealis.
Crenella glandula.
Modiolaria discors.
Modiolaria corrugata.
Leda tenuisulcata.
Pecten Islandicus.
Nucula tenuis.
Anomia aculeata.

Ascidians.

Ascidiopsis complanatus.
Glandula arenicola.
Molgula pannosa.
Leptoclinum luteolum.
Leptoclinum albidum.
Amarœcium glabrum.
Lissoclinum, sp.

Brachiopods.

Terebratulina septentrionalis.

Bryozoans.

Tubulipora crates.
Idmonea pruinosa.
Crisia eburnea.
Discofascigera lucernaria.
Caberea Ellisii.
Gemellaria loricata.
Flustra solida.
Cellularia ternata.
Cellepora scabra.
Cellepora ramulosa.

RADIATA.

Echinoderms.

Lophothuria Fabricii.
Strongylocentrotus Drö-
bachiensis.
Solaster endeca.
Asterias vulgaris.
Stephanasterias albula V.
Leptasterias, sp.
Cribrella sanguinolenta.
Ophiocnida hispida.
Amphipholis elegans.
Ophiopholis aculeata.
Ophioglypha Sarsii.
Ophioglypha robusta.

Acalephs.

Lafoëa fruticosa.
Lafoëa dumosa.
Halecium, sp.
Grammaria robusta.
Sertularia argentea.
Sertularia latiuscula.
Sertularella polyzonias.
Eudendrium tenue.

Polyps.

Urticina crassicornis. | Cornulariella modesta V., new genus and sp.*

PROTOZOA.

Sponges.

Tethya hispida.
Halichondria, several sp.
Reniera, sp.
Grantia ciliata.

Foraminifera.

Numerous species.

ALGÆ.

Laminaria longicruris.
Agarum Turneri.
Desmarestia aculeata.

The 45 fathom locality was about five miles southwest from Seguin Island. At this place we dredged many of the species enumerated in the above list, together with a number of additional ones, among which were the following:

Crustacea.

Hippolyte aculeata.
Ptilocheirus pinguis.
Diastylis quadrispinosa.
Balanus porcatus.

Annelids.

Nephthys, sp.
Rhynchobolus albus.
Trophonia aspera.
Ammochares, sp.
Terebellides Stroëmi.
Myxicola Steenstrupii.

MOLLUSCA.

Bela decussata.
Natica clausa.
Scalaria Grœnlandica.
Margarita obscura.
Cylichna alba.
Yoldia thraciformis.
Eugyra pilularis.
Amarœcium pallidum.

RADIATA.

Cerianthus borealis V.
Eudendrium ramosum.

A number of dredgings were made on and near East and West Cod Ledges, several miles off Cape Elizabeth. The shallower parts of these in 10 to 15 fathoms, are very rough and rocky, so that in some places the dredge could not be used, and even the tangles suffered seriously by the iron frame becoming caught and jammed among the rocks so firmly that

* *Cornulariella modesta* V.

Allied to *Cornularia* and *Telesto*. Polyps tubular, rising from creeping stolons; lower part of the polyp-bodies has the walls thickened and stiffened by numerous large fusiform spicula, with sharp conical projections, and is more or less eight-ribbed in contraction; upper part of body hour-glass shaped, flexible, translucent, whitish, with fewer white spicula, retractile into the lower part, the eight internal lamellæ showing through. Tentacles large, expanding about 6mm, lanceolate, gradually tapering to the acute tips, flat above, with the short thick pinnæ arranged along the upper edges on the distal half; the lower side of the tentacles is rounded and more or less swollen toward the base. Color of stolons and base of polyps dirty yellowish or brownish; flexible part of polyps and the tentacles translucent white; the latter with central rows of white spicula. Height of polyps, 6mm to 18mm; diameter, 3mm; distance between polyps, 6mm to 25mm; breadth of stolons, about 3mm.

Casco Bay; Bay of Fundy, 80 to 100 fathoms. Gulf of Saint Lawrence, in deep water (Whiteaves).

it could not be extricated without using force sufficient to bend and twist the stout iron cross-bar; at somewhat greater depths, in 20 to 30 fathoms, farther away from the crests of these ledges, the bottom was generally stony and gravelly, though often rough, and the dredges were used with good success. Most of the species from these localities have been enumerated in the two preceding lists, and need not be repeated here, but a considerable number of additional ones occurred. The roughest parts of the ledges, in 10 to 15 fathoms, are overgrown with red algæ, and among these the reddish variety of cod, known as "rock-cod," abounds. Here also a large number of interesting crustacea were obtained, most of them having red colors, evidently adapting them for concealment among the algæ. Among the crustacea were the following:

Hyas coarctatus.	H. Phippsii.	Unciola irrorata.
Cancer irroratus.	H. pusiola.	Amphithoë, sp.
Eupagurus Kroyeri.	Crangon boreas.	Caprella, sp.
E. Bernhardus.	Pandalus annulicornis.	Praniza cerina.
Hippolyte Fabricii.	Cerapus rubricornis.	Balanus porcatus, etc.
H. aculeata.		

Several of these occurred also in the previous lists, but are repeated here to show more fully the peculiar character of the fauna of these rough ledges. We ascertained that the cod-fish caught here feed chiefly on these crustacea, their stomachs often being filled with the crabs, shrimps, and smaller species named above, together with more or less numerous Mollusca, Holothurians, Ophiurans, etc. The *Ophiopholis aculeata* was a common and important part of their diet, and several specimens of a large *Thyonidium* were taken from the stomach of a cod, at this place, though we did not dredge it at all, either here or elsewhere.

Among the other species that occurred on the Cod Ledges, but not in the localities previously described, are the following:

Pycnogonids.

Phoxichilidium femoratum.	Nymphon, sp.

Annelids.

Eunoë Œrstedii.	Euphrosyne borealis.	Spirorbis quadrangularis.
Lepidonotus squamatus.	Amphitrite cirrata.	Vermilia serrula.

Gastropods.

Trophon scalariformis.	Trachydermon ruber Carp.	Tonicella marmorea Carp.
Menestho albula.		

Bryozoa.

Alcyonidium, red sp.	Tubulipora patina.	Lepralia, several sp.

Acalephs.

Lucernaria quadricornis.	Sertularia pumila?	Halecium muricatum.
Obelia geniculata.	Sertularella polyzonias.	Tubularia indivisa.

Also numerous sponges, not determined.

ALGÆ.

The following occurred in 12½ fathoms:

Agarum Turneri.	Calliblepharis ciliata.	Callithamnion, sp.
Delesseria sinuosa.	Euthora cristata.	Corallina officinalis.
D. alata.	Ptilota serrata.	Lithothamnion polymorphum.

Farther to the west, off the mouth of Casco Bay, and about two to three miles south of Half-way Rock, in 27 fathoms, we made another haul, very similar to the one in 33 fathoms, described above. The bottom was here composed of coarse sand and gravel, pebbles, small stones, and broken shells, with some mud. A large proportion of the species given in the list for the 33-fathom locality also occurred at this place, with many additional ones, among which were the following:

Crustacea.

Eupagurus Bernhardus.	Cumacea, two sp.	Ampelisca, sp. with red dorsal spots.
Crangon vulgaris.	Ptilocheirus pinguis.	Ampelisca, small sp.
Hippolyte Fabricii.	Anonyx, sp.	Anthura brachiata.

Annelids.

Nephthys, sp.	Nicomache, new sp., banded.	Pista cristata.
Ammochares, sp.		Terebellides Stroëmi.

Gastropods.

Bela decussata.	Lunatia immaculata.	Cylichna alba.
Scalaria Grœnlandica.	Margarita obscura.	Philine, sp.
Natica clausa.		

Lamellibranchs.

Cryptodon Gouldii.	Astarte quadrans.	Modiolaria nigra.
Cyclocardia Novangliæ.	Yoldia sapotilla.	

Echinoderms.

Hippasteria phrygiana, one large specimen.

In Casco Bay, among the islands, in moderately shallow water, there is great diversity in the character of the bottom, and a large amount of profitable dredging was done. Most of the species are decidedly boreal and arctic forms, which we had previously dredged in the Bay of Fundy, and farther north. The depth varied from 3 or 4 to about 30 fathoms. Some of the best localities on hard bottoms were found in Hussey Sound; off Cow Island; off the northern end of Peak's Island; off Witch Rock; off the Green Islands; off Whaleboat Island, in Broad Sound; and in the main ship-channel off Fort Preble, etc. In these localities the bottom was composed of small stones, and occasionally of rough rocks with broken shells, gravel, etc., overgrown by an abundance of coarse massive sponges, among which were several species of *Reniera*, *Halichondria*, *Suberites*, *Polymastia*, etc., together with more delicate species belonging to *Chalina*, *Isodictya*, etc.

The following are some of the more common and characteristic species dredged on the hard bottoms, in 8 to 30 fathoms:

Crustacea.

Cancer irroratus.
Hyas coarctatus.
H. araneus.
Eupagurus Bernhardus.
E. Kroyeri.
E. pubescens.
Crangon vulgaris.
Hippolyte spina.
H. Fabricii.
Hippolyte aculeata.
H. pusiola.
H. gibba.
H. Phippsii.
Pandalus annulicornis.
Mysis, sp.
Ptilocheirus pinguis.
Unciola irrorata.
Acanthozone cuspidata.
Paramphithoë? cataphractus.
Cerapus rubricornis.
Anonyx, sp.
Caprella, sp.
Idotea phosophorea Harger.
Balanus porcatus.
B. crenatus.

Annelids.

Lepidonotus squamatus.
Eunoë Œrstedii.
Harmothoë imbricata.
Phyllodoce catenula V.
Eulalia pistacia V.
Nereis pelagica.
Stephanosyllis picta, n. sp.
Procerea gracilis, new sp.
Autolytus cornutus.
Autolytus, sp.
Nothria conchylega.
Polydora, sp. (in shells).
Cirratulus cirratus.
Dodecacerea concharum.
Nicomache, new sp.
N. lumbricalis.
Trophonia aspera.
Tecturella flaccida.
Sternaspis fossor.
Cistenides granulatus.
Thelepus cincinnatus.
Scione lobata.
Amphitrite cirrata.
Polycirrus, phosporescent sp.
Myxicola Steenstrupii.
Potamilla oculifera (Leidy).
Sabella zonalis Stimp.
Chone, sp.
Spirorbis lucidus.
S. nautiloides?
S. quadrangularis St.
Vermilia serrula.
Filigrana implexa.
Phascolosoma cæmentarium.

Turbellaria.

Cosmocephala Stimpsoni V.
Nemertes affinis.
Leptoplana ellipsoides.

MOLLUSCA.

Gastropods.

Bela harpularia.
B. decussata.
B. turricula.
Admete viridula.
Trophon clathratus.
Buccinum undatum.
Neptunea decemcostata.
N. curta (Jeffrey's sp.), V.
Neptunella pygmæa V.
Tritia trivittata.
Astyris zonalis V. (dissimilis St.)
Trichotropis borealis.
Natica clausa.
Lunatia heros.
L. immaculata.
Crucibulum striatum.
Velutina zonata.
V. haliotoidea.
Lamellaria perspicua.
Menestho albula.
Scalaria Grœnlandica.
Margarita obscura.
M. Grœnlandica.
M. cinerea.
Calliostoma occidentale.
Lepeta cæca.
Cylichna alba.
Dendronotus arborescens.
Doris planulata.
Onchidoris pallida.
Doto coronata.
Tonicella marmorea Carp.
Trachydermon albus Carp.
Trachydermon ruber Carp.
Hanleia mendicaria Carp.
Amicula? Emersonii.

Lamellibranchs.

Saxicava arctica.
Mya arenaria (young).
Cyprina Islandica.
Cardium pinnulatum.
Cyclocardia borealis.
C. Novangliæ.
Astarte undata.
Crenella glandula.
Mytilus edulis.
Modiola modiolus.
Modiolaria nigra.
M. discors (lævigata).
M. corrugata.
Pecten Islandicus.
Anomia aculeata.

Ascidians.

Boltenia Bolteni.
Cynthia pyriformis.
C. echinata.
C. carnea.
Ascidiopsis complanatus.
Chelyosoma geometricum St.
Molgula pannosa.
M. retortiformis.
M. papillosa.
Amarœcium glabrum.
A. pallidum.
Lissoclinum, sp.
Leptoclinum albidum.
L. luteolum.

Brachiopods.

Terebratulina septentrionalis.

Bryozoa.

Idmonea pruinosa.	Caberea Ellisii.	M. lineata.
Crisia eburnea.	Bugula Murrayana.	Lepralia Pallasiana.
Tubulipora crates.	B. fastigiata.	Lepralia, several sp.
T. flabellaris.	Cellularia ternata.	Discopora.
Discoporella verrucosa.	Gemellaria loricata.	Cellepora scabra.
Alcyonidium (red sp., on shells).	Membranipora pilosa.	C. ramulosa.

RADIATA.

Echinoderms.

Pentacta frondosa.	Strongylocentrotus Drōbachiensis.	Solaster endeca (small).
P. calcarea.	Asterias vulgaris.	Pteraster militaris (small).
Lophothuria Fabricii.	A. littoralis (St.).	Ophiopholis aculeata.
Psolus plantapus (young).	Cribrella sanguinolenta.	Ophioglypha robusta.
Thyonidium, sp.		Amphipholis elegans.

Hydroids.

Obelia geniculata.	Halecium muricatum.	Sertularella polyzonias.
O. longissima.	Lafoëa fruticosa.	S. tricuspidata.
Campanularia flexuosa.	L. dumosa.	Hydrallmania falcata.
C. volubilis.	Antennularia antennina.	Thamnocnida tenella.
C. verticillata.	Sertularia argentea.	Eudendrium tenue.
C. angulata.	S. cupressina.	E. ramosum.
Clytia Johnstoni.	S. latiuscula.	Hydractinia polyclina.
Calycella syringa.	Diphasia fallax.	

Polyps.

Metridium marginatum.	Urticina crassicornis.	Alcyonium carneum.

Sponges.

Grantia ciliata.	Halichondria, sp.	Isodictya, sp.
Polymastia robusta? Bowerbank.	H. pannosa.	I. lobata (Esper sp.).
	Reniera, several sp.	I. infundibuliformis.
P. ———, new sp.	Suberites, sp.	Chalina oculata.
Tethya hispida (Bowerb.).	Cliona, sp.	

Besides the species enumerated above, there were many others, that have not yet been identified. Many that occurred less frequently on the hard bottoms than on sandy or muddy ones, have also been omitted from the list.

Very few genuine sandy bottoms were met with, and these were generally of small extent, so that the sand was nearly always mixed with gravel, pebbles, or mud, when brought up in the dredge, and there was, necessarily, a corresponding mixture of the animals inhabiting these different kinds of bottom. Most of the species found on such bottoms are included in the preceding list. A number of species occurred, however, on sandy bottoms more frequently, or in greater abundance, than elsewhere. Among these were the following:

Crangon vulgaris, *Unciola irrorata*, *Anonyx*, sp., *Epelys montosus* Harger, *Praxilla*, sp., *Clymenella torquata* V., *Cistenides granulatus*, *Tetrastemma*, sp., *Ophionemertes agilis* V., new gen. and

sp.,* *Lunatia heros, Menestho albula, Utriculus pertenuis, Lyonsia hyalina, L. arenata, Astarte castanea, A. quadrans, Cyprina Islandica, Echinarachnius parma.*

Muddy bottoms of various grades, and at all depths to 30 fathoms, were frequent in Casco Bay, especially in the sheltered coves and channels among the islands, and in the several branches or fiords into which the northeastern portion of the bay is divided. Among the species dredged on muddy bottoms were the following:

Pycnogonids.

Nymphon, sp.	Pallene, sp.	Phoxichilidium femoratum.

Crustacea.

Hyas coarctatus.	Mysis Americanus Smith.	Phoxus Kroyeri.
Eupagurus Kroyeri.	M. stenolepis Smith.	Corophium cylindricum.
E. pubescens.	Diastylis sculpta.	Pontoporeia, sp.
E. Bernhardus.	D. quadrispinosa.	Haploops, sp.
Crangon vulgaris.	Eudorella hispida.	Ampelisca, with red spots.
Pandalus annulicornis.	Unciola irrorata.	Anonyx, sp.
Hippolyte Gaimardii.	Cerapus rubricornis.	Orchomene, sp.
H. pusiola.	Ptilocheirus pinguis.	Idotea phosphorea Harger.
H. Fabricii.	Byblis Gaimardii.	Epelys montosus Harger.

Annelids.

Aphrodite aculeata.	Rhynchobolus albus.	Cistenides granulatus.
Harmothoë imbricata.	Polydora, sp., in shells.	C. Gouldii V.
Pholoë minuta.	Scolecolepis, sp.	Ampharete gracilis.
Nephthys, sp.	Anthostoma acutum V.	Amphicteis Gunneri.
N. ingens St.	Trophonia aspera V.	Melinna cristata.
Phyllodoce catenula V.	Ammotrypane fimbriata V.	Amphitrite brunnea V.
Phyllodoce, sp.	Ophelia, sp.	A. cirrata.
Eulalia pistacia V.	Sternaspis fossor.	Polycirrus, sp.
Eteone pusilla.	Nicomache, sp.	Chone, sp.
Nereis pelagica.	Nicomache lumbricalis.	Euchone elegans V.
Ninoë nigripes V.	Maldane Sarsii.	Chætoderma nitidulum.
Lumbriconereis, slender sp.	Praxilla, sp.	Phascolosoma cæmentarium.
L. fragilis.	Ammochares, sp.	
Goniada maculata.	Arenia, sp.	

Turbellaria.

Cosmocephala, orange sp.	Tetrastemma, sp.	Meckelia lurida V.
C. Stimpsoni V.	T. vittata V., new sp.†	Leptoplana ellipsoides.
Ophionemertes agilis V.		

* *Ophionemertes agilis* V.

Allied to *Tetrastemma*. Body slender, slightly depressed, with the sides well rounded, thickest in the middle, tapering gradually to the slender, obtuse posterior end; head somewhat separate from and wider than the anterior part of the body, changeable in form, often oval, sometimes sub-triangular, generally longer than broad, narrowed anteriorly, obtuse or slightly emarginate, with a terminal orifice. Eyes numerous, forming a long, crowded lateral row or group along each side of the head; the rows are simple and converge anteriorly, posteriorly they become broad and double. Back of the eyes there is a curved transverse groove or furrow, crossing the back of the head. No lateral fossæ observed. Color pale ochre-yellow; the intestine slightly reddish; the internal lateral organs lighter yellow, giving a reticulated appearance to the sides. Length 25^{mm} to 40^{mm}; 1·5^{mm} to 2^{mm} in diameter.

Casco Bay, 20 to 65 fathoms; Bay of Fundy, 40 to 90 fathoms.

† *Tetrastemma vittata* V.

Body short and stout, obtuse at both ends, well rounded, little depressed; head

Gastropods.

Bela harpularia.	L. immaculata.	Turritella erosa.
B. turricula.	Velutina haliotoidea	Margarita obscura.
B. pleurotomaria.	Trichotropis borealis.	M. cinerea.
Buccinum undatum (young).	Rissoa carinata.	Utriculus pertenuis.
Neptunella pygmæa.	R. exarata.	Cylichna alba.
Tritia trivittata.	R. (?) eburnea.	Philine quadrata.
Lunatia heros, var.	Scalaria Grœnlandica.	Entalis striolata.

Lamellibranchs.

Zirphæa crispata (in wood).	Serripes Grœnlandicus.	Y. thraciformis.
Mya arenaria (young).	Lucina filosa.	Y. obesa.
Saxicava arctica.	Cryptodon Gouldii.	Nucula tenuis.
Lyonsia hyalina.	Solenomya velum.	N. delphinodonta.
Thracia Conradi.	Cyclocardia borealis.	N. proxima.
T. myopsis.	C. Novangliæ.	Crenella glandula.
Eusatella Americana.	Astarte lens.	C. decussata.
Macoma sabulosa.	A. undata.	Modiolaria nigra.
Callista convexa.	Leda tenuisulcata.	M. discors (lævigata).
Cyprina Islandica.	Yoldia sapotilla.	M. corrugata.
Cardium pinnulatum.	Y. myalis.	Mytilus edulis.
C. Islandicum.	Y. limatula.	Pecten tenuicostatus.

Ascidians.

Molgula pannosa.	Eugyra pilularis.

Echinoderms.

Asterias vulgaris.	Ophioglypha Sarsii.	Ophiopholis aculeata.
Ctenodiscus crispatus.	O. robusta.	

Hydroids.

Corymorpha pendula.	Sertularia argentea (on shells).	Sertularella tricuspidata (on shells).
Hydractinia polyclina.		

Polyps.

Metridium marginatum (on shells).	Edwardsia farinacea V.	Cerianthus borealis V.
	E. sipunculoides.	

not separate from body, obtusely rounded. Eyes four, small and not very distinct, the two pairs widely separate, the anterior ones near the anterior end, and nearer together than the others. A well-marked transverse groove or fold is situated between the two pairs of eyes, and extends around to the ventral side; proboscis-orifice terminal. Color of body dark olive-green, greenish brown, or greenish black, often with a light longitudinal dorsal stripe; head greenish, marked with six longitudinal white stripes or vittæ, which radiate from the terminal orifice, and extend backward to the transverse furrow, which is bordered by a transverse band of white, often forming a whitish ring round the head; two of the vittæ are dorsal; two ventral; and one lateral on each side; a less distinct median ventral one is sometimes visible. Length, 25^{mm} to 40^{mm}; diameter, 4^{mm} to 7^{mm}.

ERRATA FOR No. XXV.

Page 439, line 14, for *Krogeri*, read *Kroyeri;* line 16, for *Nychia cirrosa*, read *Eunoë Œrstedii;* line 24, for *lucida*, read *nitidulum.*

Page 440, line 4, for *sopotilla*, read *sapotilla;* line 9, for *solidula*, read *solida;* last line of foot-note, for 1870, read 1780.

ART. X.—*Note on Fossil Woods from British Columbia, collected by Mr. Richardson;* by Principal DAWSON, LL.D., F.R.S.*

IN my note of last year on the plants collected by Mr. Richardson in 1872, I referred to specimens of fossil coniferous wood from the coal-field of Nanaimo, Vancouver Island. Mr. Richardson's collections of 1873 include a much larger number of specimens of fossil wood from the Queen Charlotte Islands, Norris Island and Hornby Island, all of them apparently from Mesozoic rocks, and many of them associated with characteristic marine shells of Cretaceous or Jurassic genera. They are principally drift trunks, though probably from not very distant land, and some of the specimens have been bored by Teredine mollusks.

Mr. Weston, the lapidary of the Survey, has prepared upwards of a hundred excellent slices of these fossils, all of which I have carefully examined, with the following general results:—

I. CONIFEROUS WOODS.—These are by much the most abundant in the collection, ranging in age from the probably Lower Cretaceous or Jurassic beds of Queen Charlotte Island to the probably Middle and Upper Cretaceous of Vancouver Island and Hornby Island. They may all be referred to the genera *Cupressoxylon* and *Taxoxylon*, or in other words are allied to the modern Cypresses and Yews, trees which range with very little modification of type from the Mesozoic to the modern period.

Cupressoxylon.—This genus is characterized by distinct concentric rings of growth, round discs or bordered pores on the walls of the fibers in one or two series, resin cells (which are, however, often very obscure in the fossil specimens), and simple medullary rays.

One of the most common woods of this type in the collections from the Queen Charlotte Islands, Vancouver Island and Hornby Island, is of the same character with the wood of the modern *Sequoia gigantea* of California, and probably belonged to an allied tree.

Another from Vancouver Island, with two rows of pores on each fiber, is scarcely distinguishable from specimens of the ordinary California Redwood, in the collection of Prof. Gray, of Cambridge, who has kindly given me specimens for comparison.

Another species, differing from the above in its very short medullary rays, and having one row of pores on the walls of the fibers, occurs at Queen Charlotte and Vancouver Islands.

* From proof received in advance of the publication of the article in the Report of the Geological Survey of Canada for 1873.

Two others, with well developed resin cells, and one row of pores on the fibers, are found at Vancouver Island alone.

I do not think it necessary to attach specific names to these trees, at least until I can compare them with more complete series of woods from the west coast. It is sufficient to know that they indicate several species of Cypress-like trees not very dissimilar from those at present existing in the region.

Taxoxylon.—This genus is characterized by consecutive lines of growth, by wood-cells with spiral fibers, in addition to the bordered pores, and by simple medullary rays.

There appear to be in the collection three species of this genus, two from Vancouver Island and one from the Queen Charlotte Islands. They have the characters of modern taxine woods, modified a little probably by the long maceration in water which they have sustained. Many of the modern taxine trees are remarkable for the toughness of their fiber, arising apparently from a less firm lateral adhesion than usual of the woody fibers to each other, and, also, perhaps, from the pecularities of their ligneous lining. This laxity of the tissue becomes exaggerated in the water-soaked fossil specimens, so that in cross section the wood-cells appear as if round within, and separated by intercellular spaces, the appearances recalling those in the Devonian *Prototaxites*, which, however, presents them in a still more exaggerated form. The study of these more modern taxine trees has served to confirm my belief in the interpretation I have given of the Devonian prototype of *Taxineæ*.

II. Angiospermous Exogens.—Wood of this class is not so abundant in the collection as coniferous wood; but it is of much interest as exhibiting the existence in the Cretaceous period of the same modifications of wood which exist at present, and as corresponding with the leaves of exogenous trees found in the coal formation of Nanaimo.

Quercus.—Two species of oak occur in the collection. One is from the Upper Cretaceous shale of Hornby Island. The other is from the Cretaceous coal field of Vancouver Island, at Trent River below the Falls, or according to Mr. Richardson's sections, about 3,000 feet lower than the Hornby Island beds.

Quercus, No. 1, Hornby Island.—This has very large medullary rays of many series of cells, the ducts small, uniformly scattered and annular. Of the species with which I have means of comparison, it most nearly resembles *Q. ilex* of the south of Europe, but has larger medullary rays. The specimen is a fragment of a decorticated stem about six inches in diameter, and to the naked eye has much the appearance of a blackened fragment of the wood of *Q. suber*.

Quercus, No. 2, Vancouver Island.—The medullary rays are narrower than in the last, and more dense. The ducts are more

collected in the vicinity of the rings of growth, and are apparently dotted. The specimen is a fragment of wood in a nodule.

Both the above species have more resemblance to European oaks than to those of Eastern America; and unfortunately I have not yet been able to procure specimens of the wood of the modern oaks of British Columbia for comparison.

Betula.—One specimen from Vancouver Island, a fragment of a stem about three inches in diameter, and with a very smooth external surface, presents the characters of Birch wood, and is not very dissimilar from the modern *Betula papyracea*. It has clustered ducts, evenly disposed and dotted on the walls, and thin-walled wood cells. The medullary rays are narrow and frequent, of about three rows of cells.

Populus.—This is also a specimen from Vancouver Island. It is a small knot or base of a branch, imbedded in a nodule. Its structure is not dissimilar from that of *Populus balsamifera*. The wood has infrequent scattered ducts and delicate medullary rays of one series of cells. Its growth-rings are distinct.

These woods afford an additional evidence of the fact already commented on by Lesquereux and Newberry, that in the Cretaceous period the generic types of American trees were as well marked as at present; and they are further curious in connection with the occurrence of workable coal, which must have been accumulated by plants thus modern in aspect.

CYCADEÆ.—*Cycadeocarpus* (Dioonites) *Columbianus*, n. sp.—This is a large and beautiful fruit, showing its internal structure, and associated with fragments of petioles and leaves, which, from the similarity of their tissues, I regard as probably belonging to the same species. I shall, therefore, describe under this head these different organs, in the hope that future discoveries may make good my judgment as to their specific identity.

(1) *Fruit*.—Broadly ovate or nearly oval. Surface smooth, but with traces of indented longitudinal bands. Apex rounded or obtusely pointed. Base showing a broad surface of attachment, with a ring of scars of about twenty-two fibrous bundles which probably passed upward on the outer rind. Length of largest specimen, 5·25 centim. Largest transverse diameter, 4·5 centim. Length of a smaller specimen, 4 centim. Largest traverse diameter, 4·25 centim. This smaller specimen has probably been vertically compressed.

When sliced, it shows an epicarp (or testa) of large and rather thick-walled hexagonal cells, without any fibers or vessels. Within this is a narrow structureless ring filled with calcite, and probably a result of shrinkage. This encloses the endocarp (or tegmen), which is thin and composed of fine cells, and apparently lined with a dense membrane. The nucleus,

which was large, has entirely disappeared, its place being occupied by structureless calcite.

(2) *Petiole.*—This is a slightly flattened cylinder, two centimeters in diameter. Externally it has a thin bark of small elongated cells, arranged in little groups in a radial manner. Within this is a continuous tissue of hexagonal cells, interspersed with what seem to be gum or proper juice-cells, darker in color, and each enclosed in a sheath of smaller cells. This cellular substance is traversed by about 45 bundles of fibers, presenting in the cross section a somewhat Hippocrepian arrangement. Thirty of these bundles, in the cross section, form a circle a little within the bark—the larger bundles being at the lower side. At the upper side is one bundle larger than those in its vicinity and of a round form, and from either side of this the remaining bundles form a deep loop extending considerably beyond the center of the petiole. Each bundle consists of fine fibers radially arranged and coarser outside, and with these are from one to five lacunæ, which in the longitudinal section seem to be oval intercellular spaces. The fibers show in places a delicate transverse or pseudo scalariform marking similar to that in modern Cycads.

(3) *Leaves.*—These have the structure well preserved, though in a fragmentary condition. The fragments are parallel-sided, about half an inch wide, thick, and traversed by strongly developed parallel fibrous bundles, imbedded in delicate cellular tissue. Each bundle is enclosed in a sheath of dense cells, and some of the fibers show the barred structure already mentioned. Between the principal bundles are secondary nerves, each consisting of a single, perhaps laticiferous, vessel. The epidermis is composed of dense irregular cells. The structures are similar on the whole to those in the pinnules of the leaf of *Dioon*, though they also remind an observer of the leaves of *Yucca gloriosa.*

On the supposition that the above described organs belong to one and the same plant, it had no doubt a thick though perhaps short stem, large compound leaves, having their divisions thick and rigid, with parallel veins, fruits or large naked seeds, supported on massive peduncles, or sessile on a common peduncle, and when mature furnished with a thick and probably dry cellular coat. No true vascular structures are apparent in any of the specimens. These characters would point to the Cycads; and, perhaps, nothing of this kind more nearly approaches to the fossil than the modern *Dioon edule* of Mexico, of which this may be regarded as a Cretaceous predecessor. It may, I think, very properly be placed in the genus *Dioonites*, created to receive certain fossil cycadeous leaves from the Mesozoic of Europe. The fruit, if described by itself, would go into the genus *Cycadeocarpus.*

The specimens are from the Lower Cretaceous or Jurassic of Skidegate Channel, Queen Charlotte Islands.

FILICES.—*Pecopteris.*—The shales of Hornby Island, along with many obscure vegetable fragments, contain pinnæ of a fern approaching in outline to *Pecopteris Phillipsii* of the English Oolite, though of much smaller size. As its venation is not preserved, I think it best not to give it a name.

The fossils from the Queen Charlotte Islands, consisting entirely of Pines and Cycads, while decidedly Mesozoic, would indicate a somewhat older stage than the others, say the Jurassic or Lower Cretaceous.

The fossils from the coal-field of Vancouver Island, embracing, in addition to coniferous trees, both wood and leaves of several species of Angiospermous Exogens, coincide with those of the Cretaceous of other parts of America, for example, of Nebraska.

The fossils from Hornby Island, in shales believed to overlie those of Vancouver Island, are also Cretaceous; and there is nothing to preclude their belonging to the upper part of that system.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Vapor-density of Potassium.*—The position of the alkali-metals in the modern chemistry scale of equivalence rests upon the assumption that the molecule of these metals is made up of but two atoms; and hence that its molecular weight, which of course is twice its density, is double its atomic weight. To test this question, DEWAR and DITTMAR have undertaken to determine the density of potassium-vapor experimentally. The great difficulties to be overcome are sufficiently obvious; but after several failures, the authors succeeded in devising the following practicable process: A cylindrical iron bottle of 200 cc. capacity, and sufficiently rigid to maintain its shape at a bright red heat, is made use of, a curved neck well ground in, and pierced with a canal 2 mm. diameter, being fitted to it. For a bath, 20 kilos. of zinc are placed in a plumbago crucible in a forge fire, by which the zinc can be brought to the boiling point. The bottle is first deoxidized interiorly by a current of dry hydrogen at a red heat; after partial cooling, 200 grams of mercury are introduced, and the bottle is placed in the red-hot zinc. After three-fourths of the mercury has distilled off, the neck is withdrawn, and an iron test-tube containing 4 or 5 grams of potassium is dropped in. The neck is then replaced, the bottle is wholly immersed in the zinc, now brought to boiling, the neck being kept clear. The potassium

volatilizes and issues in jets of vapor into the air. As soon as this distillation ceases, the nozzle is closed by a ground-in wire, and plunged beneath the surface of mercury in a test-tube. The bottle is removed from the zinc and allowed to cool. As soon as it can be handled, it is placed in recently boiled water, the wire plug is removed, and the hydrogen formed by the action of the potassium on the water pumped out by a Sprengel pump and carefully measured. From these data the vapor-density may be calculated. And, although the method needs perfecting and there are several corrections needed, the authors are confident that the vapor-density of potassium cannot be more than 45 times that of hydrogen. As therefore the question is between 39 and 78, the fact that it cannot exceed 45 makes it certain that the molecule of potassium in vapor consists of two atoms.—*Proc. Roy. Soc.*, xxi, 143, April, 1873. G. F. B.

2. *On the Hydrocarbons produced by the solution of cast-iron in acids.*—In the November number of this Journal, Mr. F. H. Williams communicated some results of his examination of the hydrocarbons evolved on treating cast-iron with acids. We have received a letter recently from Mr. H. C. Hahn, now of Wyandotte, Michigan, calling attention to the fact that he made a similar investigation in 1864, the results of which were published in Liebig's Annalen. The portions of the evolved gases which were absorbable by fuming sulphuric acid or bromine—amounting in the case of white iron to 1·26–1·6, and in the case of gray iron to 0·36–0·28 per cent by volume—consisted of ethylene, propylene, butylene, amylene and caproylene, as was proved by the boiling points, the composition and the other properties of their bromides. Acetylene was not detected. The gases not thus absorbable, which were very small in quantity, gave no satisfactory results on eudiometrical analysis. Undoubtedly marsh gas was present. The liquid products, given in greater quantity by white than by gray iron, proved to be a mixture of the homologues of ethylene, boiling between 110° and 290°. There separated out also, from the ferrous sulphate solution, on treatment with water, a disagreeably smelling oil, which, by access of air or by treatment with chlorine water, became brown and resinous. The dry residue of the iron, insoluble in acids, gave to alcohol and ether a yellow color, and there was dissolved an acid substance precipitable by lead acetate. A sulphur product was also observed. It is a noteworthy fact that in Mr. Williams's experiments in which strong hydrochloric acid was used to dissolve the iron, the hydrocarbons were evolved in the form of chlorides; while in Mr. Hahn's, in which the acid was diluted with two parts of water, they were evolved uncombined.—*Ann. Chem. Pharm.*, cxxix, 57, 1864. G. F. B.

3. *On the Optical properties of Cymene from different sources.*—Gladstone has submitted to examination eight specimens of cymene obtained by Wright from widely different sources. The following are the results obtained:

No.	Source of Cymene.	Temp.	Sp. gr.	Refractive index.		
				A.	D.	H.
1	Cumin oil,	16°	0·8569	1·4819	1·4901	1·5173
2	Preexisting in turpentine,	16°	0·8555	1·4775	1·4851	1·5111
3	" " myristicene,	16°	0·8630	1·4799	1·4876	1·5145
4	From hesperidene dibromide, I,	13°	0·8605	1·4835	1·4916	1·5196
5	" " " II,	15·5°	0·8638	1·4834	1·4909	1·5187
6	" camphor, by PCl_5,	16°	0·8621	1·4852	1·4935	1·5218
7	" myristicol, by $ZnCl_2$,	14·5°	0·8424	1·4706	1·4776	1·5021
8	" " " PCl_5,	13°	0·8620	1·4815	1·4888	1·5172

From these experimental data, the following values may be calculated; the specific refractive energy and refraction-equivalent being deduced for the line A, and the specific dispersion being the difference between the specific refractive energies for A and H:

Number.	Specific Refractive energy for A.	Specific Dispersion.	Refraction-equivalent for A.
1	0·5623	0·0414	75·3
2	0·5581	0·0393	74·7
3	0·5561	0·0401	74·5
4	0·5619	0·0419	75·3
5	0·5596	0·0409	75·0
6	0·5628	0·0424	75·4
7	0.5586	0·0374	74·8
8	0·5596	0·0404	75·0

These results Gladstone regards as practically identical and as giving the mean optical data for cymene, as follows:—

Specific refractive energy, ... 0·5599
Specific dispersion, ... 0·0405
Refraction-equivalent, ... 75·0

In 1870, Gladstone called attention to the fact that those aromatic hydrocarbons and their derivatives which had been optically examined gave a refraction-equivalent higher by six or eight than the theoretical number. Since all these bodies have a high dispersive power, this increased retardation was supposed to be due to something analogous to a change in equivalence; i. e., to the fact that the whole of the carbon atoms were not combined with two of hydrogen or one of oxygen. As cymene is an aromatic hydrocarbon, the question arises: can it be prepared from bodies not belonging in this group; and if so prepared, will it retard light similarly? The production of cymene from camphor, from hesperidene and from myristicol by Wright, answers the first part of this question in the affirmative; the above tables of Gladstone, the second, likewise affirmatively. None of these cymenes rotate a polarized ray; but the author thinks this of slight moment, believing this property to be dependent not upon composition, but upon peculiar internal structure. Refractive phenomena, however, are profoundly connected with the ultimate composition of bodies; hence, from the above results it may be inferred that in cymene its super-retardant power arises from the fact that some

of the carbon atoms are combined with less than two hydrogen atoms or their equivalent.—*J. Chem. Soc.*, II, xi, 970, Oct., 1873.

G. F. B.

4. *On the Constitution of the Allyl compounds.*—The generally received formula for allyl alcohol is $CH_2{=}CH{-}CH_2OH$; and hence many chemists assign to crotonic acid derived from it, the similar formula

$$CH_2{=}CH{-}CH_2{-}COOH.$$

But from other and independent evidence, Kekulé has assigned to crotonic acid the formula

$$CH_3{-}CH{=}CH{-}COOH.$$

If this latter formula be the correct one, then in the conversion of allyl alcohol into crotonic acid, a change in the position of the double bond uniting two of the carbon atoms takes place. KEKULÉ and RINNE have sought to ascertain by experiment at what stage of the conversion this shifting of the bonds was effected. The allyl alcohol—prepared from glycerin by means of oxalic acid—was converted into allyl iodide. That no change in structure occurred at this point was proved by converting the iodide into oxalate and from this regenerating the alcohol; it was found to be absolutely identical with that originally taken. Allyl cyanide was then carefully prepared from the iodide, and the three products, the alcohol, iodide and cyanide, submitted to oxidation. If allyl compounds have the formula $CH_3{-}CH{=}CHR$, oxidation both by chromic and by nitric acids must yield acetic and carbonic acids, and in the case of the cyanide, nitric acid must produce oxalic acid. If, however, this formula is $CH_2{=}CH{-}CH_2R$, no acetic acid will be produced, but formic (or carbonic) and oxalic acids, and from the cyanide, malonic acid or its decomposition products. On oxidizing allyl alcohol with chromic acid, carbonic gas is evolved, and formic acid, but no acetic, is produced. Nitric acid produces carbonic and oxalic but no acetic acid. Precisely the same oxidation products were yielded by the iodide. The cyanide, however, when oxidized by chromic acid, gave an abundance of acetic acid, and by nitric acid, oxalic acid in addition. These experiments prove that the alcohol and the iodide possess the same structure, corresponding to the second of the above formulas; while the cyanide is the true nitrile of crotonic acid, possessing, like this acid, the structure shown in the first formula above given. A structural change does therefore take place when the iodide becomes cyanide, and crotonic acid has the formula assigned to it originally by Kekulé.—*Ber. Berl. Chem. Ges.*, vi, 386, April.

G. F. B.

5. *On Brazilin and Resorcin.*—EMILE KOPP has subjected brazilin to a new investigation. The material was obtained from the dark brownish-red crusts which are formed in considerable quantity in the preparation of Brazil-wood extract, and which consist of brazilin and a calcium-brazilin lake. These crusts are rubbed up with water containing 5 per cent hydrochloric acid, the residue washed, and then boiled with water containing 10 to

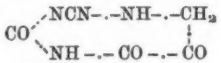
15 per cent of alcohol. On cooling, the filtrate deposits beautiful yellowish crystals of brazilin, which are pure after re-crystallization from hot water. The wash-waters and mother-liquors on evaporation to dryness with a little chalk, yield resorcin on dry distillation. Pure brazilin is colorless and yields colorless solutions, which scarcely color mordanted cotton. On standing, however, the solutions become yellow and finally reddish-yellow, acquiring a coloring power; but it is not easy to obtain crystallized brazilin from them afterward. In dilute soda solution brazilin dissolves with a splendid carmine color; this solution heated with zinc dust in a sealed tube, is reduced and becomes colorless; it is then a most delicate test for oxygen, the smallest trace of air developing an intense carmine-red. Submitted to dry distillation, brazilin affords a nearly colorless liquid distillate, which, filtered through a wet filter and concentrated on the water-bath, deposits on cooling large nearly colorless crystals of resorcin. The author recommends this method therefore, as the best by which to prepare this substance. The crystals melt at 98°–99°, and distil unchanged at 266°–267°. When treated with fuming sulphuric acid in excess, resorcin gives a characteristic reaction, being dissolved at first with an orange-yellow color, which becomes darker, greenish-blue, green, and in 20 or 30 minutes, a most magnificent blue, which, warmed to 90°–100°, becomes a splendid purple. On dilution with water the color changes to yellowish-red, which becomes deep carmine-red on adding sodium hydrate, the solution showing strong fluorescence. Kopp assigns to brazilin the formula $C_{22}H_{18}O_7$; and supposes the following relation to exist between brazilin, hematoxylin and resorcin:—

$$\underset{\text{Brazilin.}}{C_{22}H_{18}O_7} + H_2O = \underset{\text{Hematoxylin.}}{C_{16}H_{14}O_6} + \underset{\text{Resorcin.}}{C_6H_6O_2}$$

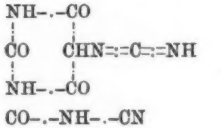
—*Ber. Berl. Chem. Ges.*, vi, 446, April, 1873. G. F. B.

6. *On the synthesis of an Isomer of Uric acid.*—Mulder has re-investigated the constitution of uric acid. The four most probable formulas for this constitution are the following:—

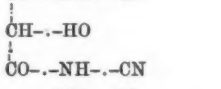
A. Strecker's.



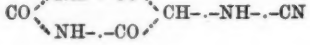
B. Erlenmeyer's.



C. Kolbe's. (Oxymaloncyanamide).



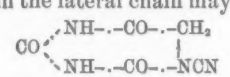
D. Mulder's (Dialurcyanamide).



The decomposition of uric acid into dialuric acid—which passes into alloxantin and alloxan by oxidation—by the action of nitric acid, makes formulas B and D the most probable. Indeed, if cyanamide is NH_2---CN, dialurcyanamide is represented by D, as above; but if cyanamide be really carbodiimide, NH=C=NH, then the same substance has the constitution given in B. Mulder has attempted the synthesis of uric acid on the supposition that its constitution was represented by one of these two formulas. Starting from the well-known fact that alloxantin, by the action of ammonia, gives dialuramide and alloxan, he assumed that by the action of cyanamide, it would give dialurcyanamide and alloxan, according to the empirical equation:

$$C_8H_4N_4O_7 + H_2N.CN = C_5H_4N_4O_3 + C_4H_2N_2O_4.$$

Cyanamide was carefully prepared by the action of ammonia gas upon an etherial solution of cyanogen bromide. Alloxantin was prepared by reducing alloxan with H_2S. Two grams alloxantin were dissolved in as little water as possible and one gram cyanamide, also dissolved in a minimum quantity of water, was added and the two boiled together. Presently a heavy pulverulent precipitate formed, recalling uric acid, and weighing 0·7 grams. It afforded on analysis the formula of uric acid, $C_5H_4N_4O_3$. Alloxan was detected in the filtrate, showing that the above reaction took place. Two grams of this powder were dissolved in potassium hydrate. On adding hydrochloric acid a gelatinous precipitate, resembling that of uric acid, was produced. But unlike this it did not become crystalline on adding an excess of acid and warming. The potash solution gives a black precipitate with silver nitrate, like uric acid. Though also almost insoluble in water, it possesses like uric acid a weak acid reaction. Mulder proposes provisionally the name *isouric acid* for the new substance, and suggests that in true uric acid the hydrogen atom now in the lateral chain may be united to CH, thus:



—*Ber. Berl. Chem. Ges.*, vi, 1233, Nov., 1873. G. F. B.

7. *On the Condensation of Gases and Liquids by Wood-charcoal. Thermic phenomena produced on the contact of Liquids and Charcoal. Liquefaction of the condensed gases;* by M. Melsens.—Absorption of chlorine by wood-charcoal may go on until it represents a weight of chlorine equal to that of the charcoal; consequently the condensing force of the latter may serve to realize the liquefaction of the non-permanent gases.

Charcoal put into a tube similar to Faraday's Λ-shaped tube is saturated with chlorine. The two extremities of this siphon tube being then sealed at the lamp, if the long branch of the tube be heated in a water-bath of boiling water, and the short branch be dipped into a freezing-mixture, a considerable quantity of chlorine leaves the charcoal and resumes the gaseous state; and under the

influence of the pressure developed, this gas liquefies in the cooled short branch.

I have in this way obtained several cubic centimeters of pure liquid chlorine. On taking the tube out of the bath, the liquid chlorine commences spontaneous ebullition, and again condenses on the charcoal, while the short branch becomes covered with a frost. This succession of phenomena can be reproduced, so to say, indefinitely; and the experiments, easy to perform at public lectures, permit the audience to observe the various phases.

Although I can only consider my experiments a trial, I have extended them to the liquefaction of several gases absorbed by the charcoal when cold and disengaged by a temperature not rising above 100° C.:—chlorine, ammonia, sulphurous, hydrosulphuric and hydrobromic acids, chloride of ethyle and cyanogen. The liquefaction of each of these gases can be demonstrated in lectures when explaining the history of those bodies.

Reflecting on the feeble thermic effects ascertained by Pouillet when pulverulent mineral matters are soaked with water, oil, alcohol or acetic ether, and on the somewhat greater effects exhibited when the same liquids are absorbed by organized substances, I asked myself if we could not succeed in ascertaining pronounced thermic effects by placing in contact with cellules of charcoal liquids which do not act upon it—water, alcohol, ordinary ether, sulphide of carbon and bromine.

The experiments exceeded my expectation. For example, with one part of charcoal and from seven to nine parts of liquid bromine, the rise of temperature exceeds 30° C., operating on only from five to ten grams of charcoal.

With charcoal well freed from gas, heated and cooled *in vacuo*, the heating due to the imbibition of bromine would doubtless be much more considerable.

The volatile liquids condensed in the pores of the charcoal (bromine, cyanhydric acid, sulphide of carbon, ordinary ether and alcohol) are not expelled, or only partially, by a temperature of 100° C. at the ordinary pressure. I made the experiment with a Faraday tube, operating as described for the liquefaction of the gases. A tube filled with charcoal saturated with alcohol does not permit any to distil at 100°.

[The tubes were exhibited to the Academy; and with them the principal experiments (the liquefaction of chlorine, cyanogen, &c.) have been repeated in the laboratory of the École Centrale. The condensation of liquid bromine by charcoal, effected upon a few grams, gave rise to a brisk rise of temperature, the mixture passing in a few minutes from 20° to 45°.]—*Comptes Rendus de l'Académie des Sciences*, Oct. 6, 1873. *Phil. Mag.*, IV, lvi, 410.

8. *Rapidity of Detonation.*—Prof. Abel and Mr. E. O. Brown have during the past ten years conducted a series of experiments on gun-cotton or pyroxilin, which serve to show us how much we have still to learn of the properties of this material. Its energy of explosion varies with the way in which it is inflamed; thus, if

gently ignited by a spark, the cotton, in the form of yarn, smoulders slowly away; when set on fire by a flame, it burns up rapidly; if in the form of a charge it is ignited in a mine or fire-arm, it explodes like gunpowder similarly placed, while, lastly, if fired with great violence with a few grains of fulminate of mercury, it is detonated with as much force and with the same terrible effect as its instigator.

More recently, our investigators have succeeded in exploding gun-cotton to the best advantage, when damp; and in this state the explosion is every bit as violent as when the material is dry. This discovery is of the utmost importance, as when very wet, gun-cotton is not only non-explosive, but positively non-inflammable. In fact it would be as serviceable as a wet towel in extinguishing a fire. When placed in contact, however, with a cake of dry gun-cotton to start the action, and ignited by a little fulminate of mercury, it explodes with the utmost violence. Moreover, the amount of water makes no difference, for it has been found that, for submarine mines, compressed cakes enclosed in a fishing-net and thrown overboard, with a dry primer and a fulminate fuse, will explode with just as much energy as when confined in a water-tight steel case.

If a line of gun-cotton cakes, placed so as to touch each other, are detonated at one end, the explosion will travel with a velocity exceeding anything we are cognizant of, with the exception of light and electricity. In one experiment, forty-two feet of the material was fired, and the velocity measured for every six feet by a Noble's chronoscope. In this case the results were most uniform, for the velocity only varied from nineteen to twenty thousand feet per second.—*Nature*, p. 534, Oct., 1873. E. C. P.

9. *Heat generated by the absorption of hydrogen by platinum black.*—M. FAVRE claims that the hydrogen set free by electrolysis is *active*, and that in passing into the ordinary gaseous condition it sets free about 4600 units of heat. This heat not being transmissible to the circuit, he calls the class of phenomena to which this allotropic change of hydrogen belongs, *meta-electrolytic*.

The action of the platinum black on hydrogen differs from that of sheets of palladium. When the gas is introduced in successive amounts in contact with the platinum black, until the point of saturation is reached, the heat set free is not constant for equal volumes of gas absorbed, as is the case with palladium. Thus for one grain of active hydrogen set free by the electrolysis of sulphuric acid, and condensed by the palladium, the first experiment, gave 8,938 units of heat, and the seventeenth 9,167. For the condensation of common gaseous hydrogen, on the contrary, the amount of heat grew less and less, being 23,075 units in the first experiments and only 13,528 in the fourth. The hydrogen condensed by the palladium seems, therefore, to spread uniformly throughout the whole mass of the metal, forming with it a true alloy, while the hydrogen condensed by platinum black seems to distribute itself like carbonic acid or ammonia in wood-charcoal,

that is, forming layers less and less dense, starting from the surface of the metal. Consider now what takes place when sulphuric acid is decomposed by a couple of zinc and palladium; and by a similar couple of zinc and platinum. In the first case, the hydrogen is absorbed directly by the palladium, and sets free 9,000 units of heat, which may be regarded as the expression of the heat due to the combination of hydrogen in the active and liquid condition with solid palladium, to form an alloy when the gas passes into the solid condition without ceasing to be active. It is no longer the same when hydrogen having the same origin is set free in the presence of platinum. In this case, the active hydrogen emerging from combination in the condition of a true explosive body, undergoes an allotropic modification and is transformed into ordinary hydrogen in the liquid condition. The amount of heat disengaged by this change is so great that the calorimeter shows about 4,600 units, notwithstanding the absorption of heat due to the passage of the hydrogen so formed from the liquid to the gaseous state.

About 20,700 units of heat are generated by the union of the hydrogen with platinum black, and adding this to the 4,600 given above, gives 25,300 as the amount which would be disengaged if the hydrogen did not undergo a transformation before its condensation by the platinum, at the surface of which it would cease to be in the active condition. The hydrogen, active and liquid, which disengages only 9,000 units of heat in uniting with the palladium, ought necessarily to remain in the active condition and to form with this metal a true explosive alloy capable of disengaging 14,000 units of heat by its decomposition.

Finally, the thermal phenomena accompanying the composition and decomposition of water are not so simple as we should at first believe. Starting with the constituent elements in their ordinary condition, the quantity of heat shown by the calorimeter is the algebraic sum of the numbers furnished by the following phenomena: 1st. Passage of the oxygen and hydrogen from their ordinary gaseous condition. 2d. Combination of these elements thus modified. 3d. Passage of the vapor of water to its liquid condition.—*Comptes Rendus*, 656, Sept. 22d, 1873. E. C. P.

10. *A new Thermo-Electric Battery.*—M. Clamond has constructed a new form of thermo-electric battery, which gives a nearly constant current as long as the temperature remains unchanged. Formerly, with Mr. Mure, he constructed batteries of galena; but they did not last, and, after some hours, or at most some days, the current diminished, and finally ceased entirely. An examination shows that the passage of the electric current finally decomposes the galena; hence a change takes place in the structure of the bars, their interior resistance increases, and the electro-motive force diminishes. Further, the galena decomposes in streaks, and consequently after some time unequal expansion takes place in the bar, causing it to crack, and thus shortly rendering it useless. In the new batteries these difficulties are completely overcome, the chemical and molecular condition of the bars remaining absolutely

the same. They have been tested for ten months by Mr. Michel, at the physical laboratory of the Sorbonne, and as a result it is found that their electro-motive force and resistance do not undergo the least change, as long as they are heated to a constant temperature.

When heated by a gas burner, they form a very convenient source of electricity for the laboratory, only requiring a match to put them in action, while, when constructed on a larger scale and heated by a coal-burning furnace, they form an excellent source of a powerful and constant current of electricity, for plating or other purposes.—*Les Mondes*, 231, Oct. 9th, 1873. E. C. P.

II. Geology and Natural History.

1. *Decomposition of Crystalline Rocks;* by T. Sterry Hunt.—Dr. T. Sterry Hunt gave some account of the crystalline rocks of the Blue Ridge and their decomposed condition, as seen by him at various points in the region to the southwest of Lynchburg, Va. They are principally gneisses with hornblendic and micaceous schists like those of the Montalban or White Mountain series, and are completely decomposed to a depth of fifty feet or more from the surface, being changed into an unctuous reddish brick-clay, in the midst of which the interbedded layers of quartz are seen retaining their original positions, and showing the highly inclined attitude of the strata. In the adit of a mine, where the rocks had been penetrated to a considerable distance, the coarsely feldspathic gneiss was found completely kaolinized, but free from the ferruginous coloring of the surface, while farther in, after passing through a partially decomposed portion, the hard, unchanged rocks were met with. A similar decomposition of the gneissic and granitic rocks in Brazil, extending to a depth of one hundred feet, has been well described by Hartt, and is known in many other regions. The speaker noticed the permeable nature of the surface soil thus formed of inclined clayey strata, which afford a natural subterranean drainage and prevent the accumulation of water in pools and lakes.

The nature of these chemical changes of the gneissic and hornblendic rocks was next considered. It consisted essentially in the removal, in the form of soluble carbonates, of the alkalies, lime and magnesia of the silicated minerals and the hydratation of the residues. The iron-oxide from these has also been in great part dissolved out by subsequent processes, and was the source of the immense deposits of hydrous iron ores which are found at the foot of the barrier range of the Blue Ridge throughout the Appalachian Valley.

The great antiquity of this chemical decomposition of the rocks was next alluded to. It was, in his opinion, effected at a time when a highly carbonated atmosphere and a climate very different from our own prevailed. That this decomposition had extended to the crystalline rocks to the northeastward he did not doubt; and he ascribed the absence of decomposed rocks from these regions

to a process of denudation during successive ages, which culminated at the time of the submergence of the northeastern Appalachians at the end of the Pliocene period, when the remaining softened material was swept away by the action of water and ice, and the hard, unchanged rocks beneath were exposed and glaciated; since which time the chemical decomposition of the surface has been insignificant.

As we proceed southwestward from New York we find that the partially decomposed and disintegrating portion of these rocks which, in the Blue Ridge, lies beneath the clays, has escaped denudation, and we at length reach the region in Southern Virginia and Carolina, where these clays, the result of complete decomposition, are seen in nearly vertical strata forming the superficial soil. These ancient clays, formed by the sub-aerial decay of the crystalline feldspathic and hornblendic rocks of the great Eozoic continental areas, were, according to the speaker, the source of the argillaceous strata of the Cenozoic, Mesozoic and Paleozoic periods, and in the heights of the southern Appalachians we have still remaining a portion of that Eozoic land, which has stood throughout all these ages, undenuded, unglaciated, unsubmerged, and from its peculiar nature (being composed, as already described, of highly inclined, porous and permeable strata, supporting an abundant vegetation), but little subject to the degrading influences of atmospheric waters.—*Boston Soc. Nat. Hist.*, Oct., 1873.

2. *Geological Survey of Missouri:* RAPHAEL PUMPELLY, Director. *Preliminary Report on the Iron Ores and Coal Fields, from the field work of* 1872. 442 pp. large 8vo, with 190 illustrations in the text, and an Atlas. Printed by the authority of the Legislature of Missouri. New York, 1873 (Julius Bien).—The Geological Survey under Prof. G. C. Swallow, begun in 1853, was suspended in 1861, in consequence of the war, without the publication of a general report of the results which had been obtained. One important volume of nearly 450 pages had been published in 1855; and besides this, only brief annual reports for 1857, 1859 and 1861. The new survey, of which the Report just now issued is the first published result, was inaugurated in 1871, when a "Mining, Metallurgical and Geological Bureau" for the State of Missouri was organized. In 1872, the Survey was commenced under Prof. Pumpelly, with the following assistants: G. C. Broadhead, R. Chauvenet, Prof. W. B. Potter, J. R. Gage, Dr. A. Schmidt, W. E. Guy, C. J. Norwood and A. Leonhard.

This first volume of the Reports contains, in Part I, a very full and valuable account of the Pilot Knob and other iron regions of the State, and their products. It commences with a chapter on the Geology of Pilot Knob and its vicinity by Prof. Pumpelly. This is followed by analyses of fuels by R. Chauvenet, and of iron ores and pig irons by A. A. Blair. Next follows a thorough discussion of the distribution, modes of occurrence, and characters of the iron ore-beds or deposits, by Dr. Schmidt.

Prof. Pumpelly states in his report that the Archæan rocks of

Pilot Knob are stratified "on an immense scale," and have the average strike N. 50° W. (true course), with the dip to the southwest. The rocks include granites and felsitic porphyries and porphyry-conglomerates. The Archæan ridges of southeastern Missouri are an extension of the Ozark range, rising like islands through the Lower Silurian strata. Pilot Knob is 1,112 feet high above St. Louis, 662 feet above its base, and 1,521 above tide. It consists at top of a stratum of porphyry-conglomerate 140 feet thick, the pebbles cemented by iron ore. The ore-bed below is 46 feet thick, and is divided by a layer of slate 10 inches to 3 feet thick; the ore-bed rests on clay-slate, below which there is a red jaspery porphyry, and other porphyritic rocks. The ore is hematite. Many details of great interest are contained in the several reports on the iron-region, of which Dr. Schmidt's occupies 150 pages.

Part II, or the following part of the volume, is devoted to geological reports on the Coal-measures of the State, and on the geology of several of the northwestern counties, by G. C. Broadhead; a report on Lincoln County, by Prof. Pollen; a report on the strength of building materials, by C. A. Smith; and a list of fossils from the Coal-measures, by C. J. Norwood.

According to Mr. Broadhead, the Coal-measures of the State cover an area of about 22,995 square miles, including 160 square miles in St. Louis County, 8 in St. Charles, and a few outliers in Lincoln and Warren, and the remainder in northwestern and western Missouri. The above area includes 8,406 square miles of Upper or Barren Coal-measures, about 2,000 of exposed Middle, and 12,420 of exposed Lower Coal-measures. The area over which there are coal beds 18 inches thick, within 200 feet of the surface, is about 7,000 square miles in extent. The maximum thickness of the Coal-measures is 1,887 feet. Mr. Broadhead has illustrated his excellent reports by numerous sections; they also contain many analyses of the coals, by Mr. Chauvenet.

The Atlas of the Report, in large folio, includes a topographical map of the Pilot Knob region; another showing its geology; another illustrating the magnetic character of the region; a map showing the distribution of the iron ores of the State; a geological map of Lincoln County; another of northern Missouri; besides various plates of geological sections. All are well engraved, and very neatly and tastefully colored. The volume throughout is an excellent commencement of the series of reports which may be expected from the survey now in progress.

Prof. Pumpelly having resigned the charge of the Survey, Mr. G. C. Broadhead has been appointed State Geologist.

3. *Return of Professor Marsh's Expedition.*—Prof. Marsh and party returned to New Haven, November 7th, after an absence of five months in the Rocky Mountain region and on the Pacific Coast. The present expedition had the same object in view as those of previous years, viz: a study of the vertebrate fossils of the west, especially those of the Cretaceous and Tertiary formations. The first explorations this year were made in the Pliocene deposits near the Niobrara River. The party fitted out in June at Fort

McPherson, Nebraska, and, accompanied by an escort of two companies of U. S. cavalry, proceeded to the Niobrara, and worked in that country for several weeks. Owing to hostile Indians, the explorations of the party here were attended with much difficulty and danger, but were on the whole quite successful. Many new animals were discovered, and ample material secured for a full investigation of those previously known from that region.

A second expedition was made in August from Fort Bridger, Wyoming, and large collections of Eocene fossil vertebrates were obtained, especially of the *Dinocerata* and *Quadrumana*, which had first been brought to light by the researches of the party in previous years. A third trip was made in September to the Tertiary beds of Idaho and Oregon, where some interesting discoveries were made. The party went from Oregon to San Francisco by sea, narrowly escaping shipwreck, and then returned east by rail. On the way, short visits were made to localities in the Miocene of Colorado, and Cretaceous of Kansas, to complete investigations began last year. The expedition as a whole was very successful, not merely on account of the large number of new animals discovered, but also on account of the extensive collections made to complete the study of those previously found. All of the collections secured are now in the Museum of Yale College.

4. *Contributions to American Botany;* by SERENO WATSON. I, II and III, 1873.—Although these important papers have been somewhat freely distributed among botanists, yet it may be useful here to note their contents, and to state where copies may be obtained. These and almost all similar publications, separate issues of articles contributed to scientific journals and proceedings of societies, may be had from the Naturalists' Agency, Salem, Mass. The great convenience of such a medium, and its importance in saving time, trouble and expense, are beginning to be appreciated.

Mr. Watson's Contribution No. 1 consists of recent gleanings from a field from which he gathered the first harvest in his botanical exploration along the 40th parallel under Clarence King. The great demand for the fine quarto volume, in which the results of his own botanical explorations through Nevada and Utah are contained, gives some idea of the value of the work. Two recent collections, made in a more southern district, viz: one by F. Bischoff in Lieut. Wheeler's exploration in 1871–72, and one by Mrs. Ellen P. Thompson, who accompanied her brother, Major Powell, in his survey of the Colorado, having been consigned to Mr. Watson for study, the new species they contained are here published in brief diagnoses, in the American Naturalist for May last. They are between twenty and thirty in number. The three most interesting plants are new species of peculiar genera, hitherto only monotypic: *Peteria Thompsoniæ*, *Whipplea Utahensis*, and *Petalonyx nitidus!* The separate issue is a pamphlet of five or six pages, and, we are sorry to say, is separately paged. The editors of the Naturalist, we trust, will hereafter keep the original paging in all such cases, for the paramount sake of facility and uniformity in citation.

Contribution No. 2, although communicated to the American Academy of Arts and Sciences as early as May 13, is published only in November. It fills the pages of the Proceedings of that Academy, vol. viii, from p. 517 to p. 618. It comprises: 1. *A revision of the extra-tropical species of the genus Lupinus*—a difficult monograph, in which 56 species are described under a systematic arrangement, and the synonymy and bibliography appended with great pains and particularity in eight or nine pages of fine type. As it would be simply impossible to clear up this genus without reference to the original types of the species published by Agardh and Lindley, it should be stated that the revision, in this regard, is based upon a collocation by Dr. Gray, at Kew, of his own specimens with those of Lindley's (the basis of Agardh's synopsis), and of Hooker's herbarium. Although this is not the same as having all these materials in the hands of the final monographer, yet there is good reason to expect that the earlier species are generally well identified. Several new ones are added, and the whole is put in such order that we may hope the genus will no longer be the most difficult one of its size in North American phænogamous botany. 2. *A revision of the extra-tropical species of Potentilla*, excluding *Sibbaldia*, *Horkelia* and *Ivesia*. 3. *Œnothera*, in a similar revision. These genera, which have much needed re-elaboration, are here worked upon the same plan as that for *Lupinus*. First, there is, in small type, a synopsis of the sections and species, serving as a key; then the fuller descriptions, with little or no synonymy; then, in small type, full synonymy and references, under an alphabetical order of the admitted species, including also collector's numbers; and, finally, a table of cross-references of synonyms to the species. It is pleasant to see such neat and faithful work.

Contribution No. 3, on *Polygonum*, section *Avicularia*, after some prefatory remarks, disposes of fourteen North American species of this troublesome group, we hope satisfactorily; only one of them, *P. Torreyi*, from California, absolutely new; and a new section *Duravia*, is made for Meisner's *P. Californicum*, which is separated from the *Avicularia* section "by every character but habit." This short paper was published by the American Naturalist, in the November number.

5. *Characters of New Ferns from Mexico;* by Daniel C. Eaton.—Being two new *Polypodia* and an *Asplenium*, from a collection made at Chiapas, a southern province of Mexico, by Ghiesbreght, which Prof. Eaton has recently distributed, extracted from Proceedings of the American Academy, for May 13, 1873.

The eighth volume of these Proceedings, under the same date, contains a paper (also issued in a separate edition), entitled

6. *Botanical Contributions*, by Asa Gray, bearing date of issue November 18, 1873. This contains, 1. *Characters of New Genera and Species of Plants.* The new genera are *Brewerina*, a new Caryophyllaceous genus (said to be "*Silenearum*," but this is a misprint for *Alsinearum*, as the context shows), from the Sierra

Nevada in California, therefore appropriately dedicated to Prof. Wm. H. Brewer of Yale College, from whom we are expecting the Flora of California; and *Ghiesbreghtia*, a striking new Scrophulariaceous genus from Southern Mexico. As to new species, all but one are from the Rocky Mountains, or farther west. The eastern one, of particular interest, is *Pachystigma Canbyi*, a second species of this formerly monotypic genus, discovered by Mr. Canby in the Virginian Alleghanies. Here is a western genus now augmented by an eastern species, evidently very local, and overlooked until Mr. Canby set eyes upon it. "To redress the balance," a new Californian *Dirca* is here published, *D. occidentalis*, which represents our *D. palustris* on the western verge of the continent. 2. *Notes on Compositæ and Characters of certain Genera and Species*, is in some sort a review of a portion of the new part of Bentham and Hooker's *Genera Plantarum*, so far as it came in the way of a particular line of study, with some revisions, new species, &c. The most extensive is the monograph of the re-established and augmented genus *Bigelovia*. The "golden crown" to which DeCandolle gracefully alluded when he founded the genus, almost thirty years ago, in honor of Dr. Jacob Bigelow, now in his old age, has its stars increased to the round number of twenty-four. A. G.

5. *Yucca gloriosa.*—Since our notice of Dr. Engelmann's Monograph of *Yucca* was printed (in December number), we learn from him that *Y. gloriosa* has fruited in the Congressional Garden at Washington, where it has been examined and photographed by Dr. Schott. This species proves to have a dry capsular pod, like that of *Y. filamentosa*, not a baccate fruit, as Elliott, Nuttall and, after them, Chapman supposed. What they took for the fruit of this species must have belonged to *Y. aloifolia*. A. G.

6. *Arundo Donax in Virginia.*—Along the banks of a stream, about five miles southeast of the Peaks of Otter, in the Blue Ridge, Virginia, Mr. A. H. Curtiss, this autumn, found in flower a tall reed, from fifteen to eighteen feet high, which proves to be *Arundo Donax*, or at least is not to be distinguished from it as to the inflorescence and spikelets; the leaves not seen by me. There are one or two almost peculiarly European plants in the Virginian Alleghanies, such as *Convallaria majalis* and a large form of *Anemone nemorosa*, seemingly passing into *A. trifolia*, which Mr. Curtiss discovered last year. But *Arundo Donax* belongs to the Mediterranean region, and is not a plant which would be expected to endure, still less to be indigenous in our Alleghanian region. I have no idea that the imported plant would survive there. The fact of its survival, and the circumstances under which it occurs, render it probable that it is no new comer. A. G.

7. *Trichomanes radicans in Kentucky.*—This discovery, which unexpectedly adds this fern to the botany of the northern United States and extends its range up to about lat. 38°, will be mentioned more particularly in a later number of the Journal. A. G.

8. *Flora Australiensis;* by GEORGE BENTHAM, assisted by BARON FERDINAND VON MÜLLER. Vol. VI. *Thymeleæ to Dioscorideæ.* 8vo, pp. 475. 1873.—The fifth volume appeared in 1870. Since then Mr. Bentham has been able to bring out this new volume, besides re-elaborating the whole order *Compositæ* for the *Genera Plantarum*, not to speak of other things. That the work is not slighted may be inferred from a remark incidentally made under the *Orchideæ*—the largest order in this volume, and particularly tedious and difficult to study in dried specimens —that, "In this case, as in the rest of the present work, I have made it a rule to work out the descriptions of genera as well as species, in the first instance from the specimens themselves, wherever they admitted of examination, and afterward to check them by those of the great authorities on the order."

The more noteworthy points which have attracted attention in turning over the pages are the following: *Phaleria* of Jack is an older name for *Drymispermum* of Reinwardt. A *Nepenthes* has been discovered in Australia; yet it may be a form of *N. phyllamphora*. *Trema* of Loureiro replaces *Sponia*, the character of the former being not only earlier but as definite as Commerson's of the latter. The carpological characters of *Coniferæ* are given with an *alias*, although the gymnospermous view is adopted, "as most conformable to the actual appearance," "without, however, intending to decide the question, which is still the subject of keen controversy." The *Hæmodoreæ* are reduced to a tribe of *Amaryllideæ*. A. G.

9. *Flora Brasiliensis*, fasc. 62, issued in June last, of 180 pages and 50 plates, commences the *Compositæ*, and contains the tribe *Vernoniaceæ;* by Mr. Baker of Kew. This tribe is largely represented through the eastern side of South America, increasing in number southward. Although diminished by the separation of several small groups, 178 species of *Vernonia* are here described as belonging to Brazil. A. G.

10. *Musée Botanique de Leide*, par W. F. R. SURINGAR. Vol. I. livr. 1–3. 4to. The second titles are *Illustration des Espèces et Formes du Genres d'Algues; Gioiopeltes.* 1871–2: with twenty-two plates. *Illustration des Algues du Japon*, with four plates. —With this elegant work, the letter-press and illustrations in the best style, Prof. Suringar begins anew the botanical publications of the researches made in the Royal Herbarium at Leyden, which had been interrupted by the death of Professor Miquel. The *Algæ* of Japan will be of special interest in this country. Some good work done by the late Professor Harvey, upon collections sent from this country, still remains unpublished. A. G.

11. *De Candolle's Prodromus, pars decima septima*, issued Oct. 16, 1873, has come to hand. The contents are, in the first place, certain small outlying orders, or some of them genera, that have to do duty as orders, which on various accounts have been left out of the Prodromus as it went on, viz: *Sarraceniaceæ*, *Phytocreneæ*, *Cardiopteridæ*, *Salvadoraceæ*, *Cynocrambe*, *Bati-*

daceæ (one *Batis*), *Lennonaceæ* (by Solms-Laubach), *Podostemaceæ* (by Weddell). Then *Nepenthaceæ*, by Dr. Hooker; *Cytinaceæ*, by the same; *Balanophoraceæ*, by Eichler; *Ulmaceæ*, by Planchon; *Moraceæ*, by Bureau; and a synopsis of the genera of *Artocarpeæ*. For the complete elaboration of this last family the volume has been a good while kept back, and has at length been issued, and (sad to say) the work concluded, without it. It is to be hoped that whenever M. Bureau finishes his undertaking, the publishers of the Prodromus may print the *Artocarpeæ* uniformly with the rest, so that it may be appended.

Then follow a few pages of *Genera omissa*, with brief references, indicating what they are, or may be, so far as has been made out or conjectured; and finally, the wearied editor appends his *Prodromi Historia, Numeri, Conclusio.* It is a terse and highly interesting account of this work, which (including the two preceding volumes of *Systema*) occupied his celebrated and indefatigable father from the year 1816, or earlier, down to the end of his life, in 1841, and himself to the close of the past year; an enumeration of the contributors, who have worked up particular families or genera; an enumeration of the orders, specifying the volume which contains each, and the number of genera and species described, 5134 genera and 58,975 species, which the missing *Artocarpeæ*, it is estimated, would bring up to 5163 genera and about 60,000 species of *Dicotyledones.* Among a few statistical data which are given, the ten orders are enumerated which contain the greatest number of genera, beginning with *Compositæ* and ending with *Cruciferæ.* Then the ten which most abound in species, which begin with *Compositæ* (8561 species) and end with *Umbelliferæ* (1016). *Leguminoseæ* are the second in both lists, and next *Rubiaceæ* in the former and *Euphorbiaceæ* in the latter. But the long interval between the publication of many orders, say between *Cruciferæ* and *Euphorbiaceæ*, much diminishes the value of such comparisons. The reasons which have prevented a more rapid publication of the volumes of the Prodromus, especially since the work has been largely distributed among collaborators, are hinted at; and finally the regretable announcement is made that the publication is now relinquished, at the close of the *Dicotyledones.* A full Index, down to genera and their sections, filling 170 pages, closes this great work.

We sincerely congratulate the editor upon the successful completion of this great undertaking at the limits he felt obliged to prescribe, and thank him heartily for his long and faithful service and many sacrifices. As it may be hoped that he has still years of good work in him, all will regret that he could not bear this burden through a few of them, while a half dozen collaborators, who might be named, elaborate the Monocotyledonous orders. But, as he declares that he should doubtless perish under it, we prefer the living botanist to the completed *Prodromus.* We may expect from him original work instead of editorial drudgery, perhaps a new edition of his Geographical Botany, or new researches

upon the same subject, investigated with his impartial judgment, under the new light which was just dawning when that comprehensive treatise was published.

Since these remarks were written we have received an interesting pamphlet, separately issued from the *Archives des Sciences* of the *Bibliothèque Universelle* for November, entitled, *Reflexions sur les Ouvrages Généraux de Botanique Descriptive.* In this M. de Candolle gives the history of the Prodromus and its forerunner with considerable fulness, explains more particularly his editorial trials and burdens, and the reasons why the work could not be made to get on faster, and gives his views as to the most practicable method of combining the labors of the botanists of another generation in the production of the new *Systema Vegetabilium* which will be demanded. An estimate is made of the time it must needs require, even with all the available monographers of the day enlisted in the service. The increased difficulties, or at least the augmented labor, of systematic botanical work, under the present demands of the science, are indicated. It appears that, while in his father's time one could elaborate at the rate of about ten species a day, a faithful monographer now, under the modern requirements, can seldom exceed three or four hundred species *per annum*, that is, about a species a day! We suppose that the case on the whole is not overstated. A. G.

12. *Description of a new Genus and Species of Alcyonoid Polyp;* by ROBERT E. C. STEARNS. (From the Proceedings of the Cal. Academy of Sciences, August 18, 1873.)—At a meeting of the California Academy of Sciences, held on the third day of February, 1873, a paper was read by me, entitled "Remarks on a New Alcyonoid Polyp, from Burrard's Inlet;" * in which I gave a *resumé* of the discussions, notices, etc., in this country and in England, arising from the examination by several naturalists of certain "switch"-like forms, which had been received by different parties from the Gulf of Georgia (more particularly from Burrard's Inlet, in said gulf), several specimens of said "switches" being in the Museum of the California Academy.

These "switches," or rods, were referred by Dr. Gray, of the British Museum, to his genus "Osteocella," and by Mr. Sclater's correspondent stated to belong to "a sort of fish;" but by the majority of scientific gentlemen who had seen these "switches" they were regarded as belonging to a species of Alcyonoid Polyp. I expressed the belief that they belonged to a species of *Umbellularia.*

At a meeting of the California Academy, held on the evening of August 4, 1873, Dr. James Blake presented a specimen of the polyp of which these so-called switches are the axes, which had been sent to him from the Gulf of Georgia by his friend, Capt. Doane. This specimen was one of six or seven sent at the same time, all of which were in a tolerable state of preservation, though, as might have been anticipated, the more delicate tissues of the

* *Vide* Proceed. Cal. Acad. Sciences, vol. v, part I, pp. 7—12.

polyps are somewhat decomposed, and some of the specimens are in some places lacerated. They all are, however, sufficiently perfect to determine the true position, and show that the "switches" are, as was supposed, the supporting stalks or axes of an Alcyonoid Polyp "related or pertaining to the group *Pennatulidæ*."

At the last meeting, I referred the specimen before the Academy to that division of the *Pennatulidæ* known as *Virgularia;* but, upon a subsequent examination of the authorities, I find that those forms in which the axis is unilateral, or on one side, come within the genus *Pavonaria* of Cuvier.

The only species heretofore described, so far as I can learn, and on which this genus is based, is *P. quadrangularis*, of which a long and interesting description from Prof. Forbes is given in Johnston's British Zoöphytes (vol. i, pp. 164–166). In that species, however, the axis is "acutely quadrangular," and the polyps are arranged in three longitudinal series, corresponding to three of the "angles of the stem."

In the specimen presented by Dr. Blake, the style of axis is round and the polyps are arranged in two longitudinal unilateral series, which conform to the convexity of the external fleshy covering. With these differences, I think I am justified in placing it in a new sub-genus, for which I propose the name of *Verrillia*, in honor of Prof. Verrill of Yale College.

Genus PAVONARIA Cuvier. Sub-genus *Verrillia* Stearns.—Polypidom linear-elongate, round, oval or ovate in cross-section. Axis round, slender, bony; polyps arranged in two unilateral longitudinal series.

Verrillia Blakei Stearns, n. s.

Polyp-mass or polypidom of a flesh or pink color, linear, elongate, attenuate; polypiferous portion about three-fourths of the entire length, rounded oval to ovate elliptic in cross section, and from three-fourths to one inch in greatest diameter, flatly tapering toward the tip, as well as decreasing in the opposite direction to where the polypiferous rows terminate or become obsolete. From this latter point to the beginning of the base or root, a portion of the polypidom, equal to about one-sixth of its entire length, is quite slender, being only about twice the diameter of the naked axis, and the surface quite smooth; said portion, as well as the base, is round (in cross section); the basal part is from one-ninth to one-eleventh of the entire length, and about one inch in diameter, with the surface longitudinally wrinkled or contracted, presenting a ridged or fibrous appearance.

Style or axis long, slender, white, hard, bony, somewhat polished, about three-sixteenths of an inch in diameter in the thickest part, tapering gradually toward the tip, and attenuated, with surface somewhat roughened toward the basal extremity. Inclosed in the polyp-mass or polypidom, the axis is central from the base to where the polyp-rows begin, when it soon becomes marginal or lateral, forming a prominent rounded edge (free from polyps) on one side of the polypiferous portion of the whole.

From near the sides of the axial edge, the polyp-rows start, and run obliquely upward to the opposite side, where they nearly meet, presenting, when that side is observed from above, a concentric chevron or Λ-like arrangement, modified by the convexity of the polypidom. The more conspicuous polyp-rows show from nine to fourteen polyps, with occasional intermediate rows of three or more polyps.

The length of the most perfect of Dr. Blake's specimens was *sixty-six* inches; of which, commencing at the tip, a length of forty-eight and a quarter inches was occupied by the polyp-rows, which numbered two hundred and forty-five, or twice that number when both sides or arms of the chevron or Λ are considered. The number of polyps in each row was, in this specimen, from eight to eleven, with occasional intermediate shorter rows of from three to seven. Estimating ten to the row, this specimen exhibited about *five thousand* polyps, all of which, as well as the polyps in the other specimens, were filled with ova, of an orange color. In the next section of this specimen, the length between the last polyp-row and the swell of the base or root, is eleven and one quarter inches; thence to the termination of the base, six inches.

The average dimensions of thirty-six of the axes in the Museum of the California Academy is five feet six and one-third inches in length, and the diameter of the largest, nine thirty-seconds of an inch; diameter of smallest specimen, one-sixteenth of an inch.

Dr. Blake's specimens were preserved in a mixture of glycerine and alcohol; and the more delicate tissue of the polyps appears to have been somewhat injured by the latter ingredient.

Additional specimens of the above species, from the same locality, have been received from J. S. Lawson, Esq., of the U. S. Coast Survey, by George Davidson, Esq., President of the Academy. These latter were put in glycerine only, and are in better condition than those received by Dr. Blake.

Of the specimens received from Mr. Lawson, some individuals are younger than either of Dr. Blake's. In these the polyp-rows are farther apart, and there are not so many polyps in the row; neither do the ends of the rows approximate so closely on the side opposite the axial edge, the polyps being not nearly so many in the same length, or presenting (as do some of Dr. Blake's specimens) so crowded an appearance. In cross-section through the polypiferous portions, the younger individuals are less oval or acutely-ovate than the older specimens. A comparison of individuals indicates an external differentiation, analogous to that displayed by specimens of the same species in *Virgularia*. The general aspect of this species, judging from the figure in plate XXXI of Johnston's British Zoophytes (2d ed.), is like *P. quadrangularis* from Oban, only, in that species, the rows of polyps, it is stated, are composed of "four, five or six polyps in a row," one figure showing seven.

Note.—A recent examination of a specimen, convinces me that this species is most nearly allied to the *Halipteris Christii* Kölliker (Koren and Dan., sp.) and probably ought to be referred to the same genus.—A. E. VERRILL.

III. Astronomy.

1. "*Rapporti sulle Osservazioni dell' Eclisse totale di Sole, del 22 Dicembre*, 1870, eseguite in Sicilia dalla Commissione Italiana."—This work is a quarto of 214 pages, handsomely printed and gotten up, and illustrated with fourteen fine lithographic plates. It is published at the expense of the Italian Government, under the editorship of Professor G. Cacciatore, the Vice-President of the Commission, and is in all respects a most creditable exponent of the scientific activity of Italy.

The Commission was named by a Royal decree, dated July 5, 1869, and originally consisted of Professors Santini, Cacciatore, A. de Gasparis, Donati and Schiaparelli. At their first meeting, they added to their numbers Father Secchi and Professor Blaserna, and at the same time elected the venerable Santini as their President, and Cacciatore as Vice-President.

The volume opens with a short letter addressed to the Minister of Public Instruction by Santini, recounting the organization of the Commission, explaining the writer's part in the work, (which, on account of his advanced age, was chiefly that of general supervision,) and returning thanks for the zeal and energy with which the minister entered into and seconded their plans.

This is followed by a more extended and very interesting paper (*relazione*) by Prof. Cacciatore, upon whom fell most of the labor of organization and arrangement of details. This labor was much increased by the disturbed condition of Europe, which rendered it very difficult to procure some of the needed instruments, and finally, on this account, compelled material changes in the programme of operations.

At the stations occupied by the Italian Commission, the weather also during the eclipse was of the same character as at all the others, cloudy with mere snatches of clear sky, so that altogether he found his labors arduous and rugged ("*ben ardua e scabrosa*"), and the results but partially satisfactory. We copy his summary in his own words:

"As soon as nature resumed its course, I was able to satisfy myself that if the sky had not been largely propitious, it had yet conceded to us a certain interval, the fruits of which had been reaped to the uttermost, and that, if on the whole the observations of the eclipse of 1870 had failed of success (*riuscirono disgraziate*), yet the Augusta division would be able to present some facts not unimportant in the present state of science."

* * * * "Father Secchi had undertaken the photography and the spectroscopic examination of the protuberances before the eclipse, with the view of comparing their appearance thus observed with that presented during the eclipse. Their form and position were obtained during the morning under a favorable sky. The first contact was observed by him with a chronometer.

"Ten photographs were obtained during the phases, and at the moment of totality a photograph of the protuberances, in spite of

interposing clouds. The spectrum of the acute cusps of the sun was also studied.

"Prof. Denza made spectroscopic observations of the corona, which revealed two bright lines, one near E, the other probably of nitrogen. [*Very doubtful.*—Y.] Together with Sig. de Lisa he observed and sketched the prominences. Prof. Donati, during the totality was able to catch the lines in the spectrum of one protuberance which he had observed before the eclipse. He saw the hydrogen lines and D_3, but none of the iron lines.

"Prof. Blaserna examined whether the corona contained polarized light. Using a Savart polariscope applied to a telescope of moderate magnifying power, he was able to examine carefully three points situated about 45° from each other (*on the sun's limb*). The polarization was most pronounced, and very nearly the same as that of a portion of clear sky observed soon after, about 50° from the sun. At the distance of a diameter and a half from the moon every trace of polarization vanished, so that the influence of the air was certainly eliminated in the observed phenomenon.

"The plane of polarization was found at all points either radial or tangential to the sun's limb [*the observations not deciding with certainty which*]. It remains therefore established that the corona is polarized, and contains reflected light derived from the photosphere.

"The purely astronomical part assigned to myself was executed to the best of my ability, so far as the variable condition of the sky permitted. I was able in fact to note with some precision the instants of first contact, of the beginning of totality, and of its ending (the last through clouds), besides making some other observations to be referred to hereafter.

"The magnetic and meteorological observations which since the 10th had been kept up hourly, were taken at intervals of five minutes, beginning at noon of the 22d. Sig. Bonifacio, who was especially charged with this work, was aided in it by Prof. Cultrera of Palermo, who having come to Augusta to witness the phenomenon, begged earnestly to participate in the labors of the Commission.

"The division at Terranova found themselves in circumstances very similar to those which prevailed at Augusta; here also the observers were annoyed by tempestuous winds and opposed by clouds; but notwithstanding, some good and not unimportant observations were obtained. Prof. Lorenzoni detected in the spectrum of a protuberance, besides the hydrogen lines and D_3 a large number of bright lines ('*more than twenty*'). In conjunction with Prof. Tacchini, he made excellent sketches of the protuberances as seen with the telescope, and carefully determined the position of one green line in the spectrum of the corona.

"Prof. Nobile was able to observe the spectrum of the cusps (*showing* '*at least forty bright lines*').

"Prof. Legnazzi, rising from a sick bed to fulfill his part, observed the contacts and the protuberances. The physical fea-

tures of the eclipse were studied by Sigs. A. Tacchini, Solito and Rizzo, the phenomena of the shadow by Capt. Serra.

"Finally, Sig. Muller considered that his magnetic observations brought out an important fact, never before observed, viz: that of a magnetic disturbance, simultaneous with the phases of the eclipse, perceptible at all the stations, but diminishing in amplitude as the distance from the center of the shadow increased."

Following this "*relazione*" of Prof. Cacciatore, and forming the principal portion of the book, come the detailed reports of the different observers, describing their stations, apparatus and modes of observation, the operations for the determination of time and geographical position, and the results arrived at by each. Part First contains the reports of the observers of the Augusta division, in the following order: Secchi, Donati, Cacciatore, Blaserna, De Lisa and Denza. Part Second contains the Terranova reports from Lorenzoni, Legnazzi, Nobile, A. Tacchini, P. Tacchini, Muller and Serra.

An appendix of some 17 pages contains certain observations of Prof. Semieri, Cav. Buffa di Ferrero and others, for the most part designed to determine very exactly the northern limit of the shadow on the Italian coast.

Our space will not permit any extended analysis of these numerous papers, among which those by Secchi, Blaserna, Denza, P. Tacchini, Lorenzoni and Nobile appear to be the most interesting and important. Such an analysis, however, is less needed, since for the most part the results obtained agree with those of the American and English observers, which are well known to our readers.

Prof. Denza, however, thus far stands alone in his observation of the second bright line in the spectrum of the corona; and the observation of Sig. Muller, as to a magnetic disturbance accompanying the progress of the shadow, failed of confirmation in the Indian eclipse of 1871.

It is to be noted, moreover, that both Denza and Lorenzoni agree in declaring the position of the green corona line to be at 1463 of Kirchoff's scale, and not 1474, as given by Young. In this they are certainly mistaken. We think that any one who will read the account of the manner in which the determination of the American observer was made [this Journal, Nov., 1869, and May, 1871; also Nature, vol. iii, p. 272, and vol. vii, p. 28,] will be quite satisfied as to this point.

Prof. Denza's determination was confessedly a mere estimate; that of Lorenzoni was a careful scale-reading, three times repeated, with a direct vision spectroscope having about twice the dispersion of the ordinary single-prism chemical instruments—if, at least, we may judge from the separation of the D lines indicated by the scale-reading.

He writes, "As soon as the totality was ended, I re-compared the solar spectrum, and found that the position of the corona-line coincided exactly with that of line No. 21 of the spectrum of Vander Willingen—1463 Kirchoff.

"The same consequence also results from the following readings made upon the scale, viz: D^1, 73·2; D^2, 73·6; corona line, 118·5; b^1, 133·5; b^2, 134·8; b^3 135·2."

The force of this last sentence is not very evident, since, if we take Kirchoff's numbers for the D's and b's [1002·8, 1006·8, 1634·1, 1648·8 and 1654·7], we find, on performing the interpolation, that 118·5 of Lorenzoni's scale comes out correspondent with 1478·3 Kirchoff, instead of 1463. Since the probable error of a reading is stated by Prof. Lorenzoni, in a note dated March, 1872, to be four divisions of Kirchoff's scale, the agreement with Young's result would seem to be as close as could be desired. We should not have noticed this point so particularly were it not evident, from the note referred to, that the Italian observers, after having their attention specially called to the subject, were still disposed to prefer their own result to that which is generally accepted.

C. A. Y.

IV. Miscellaneous Scientific Intelligence.

1. *Note on Subterranean Fishes in California;* by A. W. Chase. (Communicated to one of the Editors.)—In collecting facts about the *Artesian wells of the lower Counties*, I received the following curious information from Mr. Bard, the agent of the California Petroleum Company at San Buenaventura. He has lately constructed a wharf at Point Hueneme, southeast of San Buenaventura. Wanting water to supply this wharf, he commenced sinking an artesian well on the *sea beach*, not five feet from high-water mark. At the depth of 143 feet, a strong flow of water was obtained, which spouted forth to a height of thirty feet. It was controlled with a "goose neck" and utilized. One day while the agent was absent, the men around the well noticed fish in the waste water. On his return they called his attention to the fact, and on examination the well was found to be filled with young trout, thousands of them being thrown out at every jet. These trout were all the same size (about two inches long), and perfectly developed. The first examination made was to see whether they had *eyes*. These were found perfect. Now there is no stream nearer than the Santa Clara River, several miles distant. Could these fish then have come from its head-waters by some subterranean outlet? There are no trout in the lower portions of the stream. The temperature of the water is the same as that of the wells in this county, viz: 64° Fahr., too warm of course for trout to live long in it.

2. *La Naturaleza, Periodico cientifico de la Sociedad Mexicana de Historia Natural*, in monthly numbers of 24 to 32 pp., large 8vo. Mexico.—This publication of the Mexican Society of Natural History was commenced in June, 1869, and is now in charge of Señor Mariano Barcena, 1st Secretary of the Society. It contains the papers read before the Society, treating of all departments of science. Among these are papers on Mexican Insects and Vertebrates, by D. E. Dugés (one on a new species of Axolotl); on Insects, by D. J. Blasquez; on Mexican Helminthology, by D. A.

Peñafiel; the geographical distribution of birds, by D. F. Sumichrast; on Mexican Mammifers, by D. M. M. Villada; on Cacteæ, by D. J. M. Velasco; new grasses, by D. V. Cervantes; habits of *Quiscalus macrourus*, by D. M. Barcena, and among the others the following:

On a new Mexican mineral, by Don Pedro L Monroy (i, p. 76). The mineral contains chiefly bismuth and tellurium, with perhaps a little sulphur, arsenic and silver. G.=8·23; H.=3·75–4, on the scale of Breithaupt; luster metallic; color between steel gray and the white of antimony, but tarnishes to bronze and iron black; powder grayish-black; somewhat ductile. The specimen was labeled from the mine of Coneto, near Durango.

On some combustible minerals of Mexico, by Don P. L. Monroy (i, p. 87). The paper contains analyses of coals and lignite, from La Villa de Panuco, Vera Cruz; between Xilitla and Jacala; Xilitla; Pez de Jalapa; Yahualica, State of Hidalgo; Chilpangingo, State of Guerrero; Paso del Norte, Chihuahua; Zacualtipan, Hidalgo; Texmelucan, Puebla.

Ascent of Popocatepetl in 1865, by A. Dolfus, E. de Montserrat and P. Pavie, with two plates of views and sections. The heights measured are: the summit of Popocatepetl, 5,425 meters; bottom of the crater, 5,119 meters; diameter of the crater at top, 825·68 meters; height of Ixtaccihuatl, 5,207 meters. Eruptions have taken place from Popocatepetl in the years 1519, 1530, 1548, 1571, 1592, 1642, 1664, 1802.

On the active volcano, Ceboruco (near the village of Ahuacatlan), by Don A. Caravantes, with a plate. The height of the volcano above the sea-level is 1,525 meters.

On the meteoric irons of Mexico, by D. J. Correjo (i, p. 252). A review of the facts, including analyses, which have been published with regard to Mexican meteorites, and some additional facts. A recent number contains an indignant protest of the society with reference to the destruction of the large meteorite, called the "Descubridora," ordered by the Mexican Society of Geography and Statistics.

3. *Notes on a Metallurgical Journey in Europe;* by JOHN A. CHURCH, M.E., with 22 illustrations. New York, 1873. 8vo, pp. 102. (Van Nostrand).—So much exact and valuable information on a technical art is rarely crowded into the same space as is to be found in the one hundred closely printed pages of Mr. Church's "Notes" of his metallurgical journey in Europe. The topics discussed are concisely handled in the analytic method, and with a fullness of detail which makes the work of permanent value. The copper process at Agordo; the mercury works at Valalta; the lead works at Mechernich; the gold and silver works at Lend; occupy 53 pages, rich in information and details drawn from the most authentic sources. Since 1870 the processes at Freiberg have been so much changed that Mr. Church's chapter of 28 pages devoted to them will be read with great interest. The lead and silver works of the Hartz Mountains, Clausthal, Lautenthal, and the copper process at Altenau, complete this use-

ful and unpretending memoir, which appeared first in a series of articles in the Engineering and Mining Journal of New York during the past year.

4. *Qualitative Chemical Analysis. A Guide in the Practical Study of Chemistry and in the work of Analysis;* by SILAS H. DOUGLASS, Professor of Chemistry, and ALBERT B. PRESCOTT, Professor of Applied Chemistry in the University of Michigan. Ann Arbor; 1874. 8vo, pp. 259.—Messrs. Douglass and Prescott have embodied in this volume the results of their own experience in the management of the classes in qualitative analysis in the University of Michigan. For those commencing the study of chemical analysis, this book will be found convenient as embodying in one volume what is most essential to be known, and presenting the subject with a fullness of detail in some particulars not always found in similar works. The dark-faced barred type are retained in the formulas, which we think is to be regretted as tending to confuse the mind of the student, where there is no occasion for such confusion if the atomic notation was strictly adhered to. Following the systematic discussion of the metals, nonmetals and acids, are lists of solubilities of salts with reference to bases and acids; a table of relative solubilities; and two tables for the systematic qualitative analysis of simple and complex substances, both in the dry and wet way. These are substantially the same tables which Prof. Douglass published in successive editions in 1864–65 and 1868, for use in connection with Fresenius' Manual of Qualitative Analysis. A list of chemical reagents closes the volume, which the authors hope may aid "to prevent habits of mechanical manipulation and of superficial observation in analysis."

5. *The Service Monthly, a Monthly Journal devoted to Meteorology, Military Telegraphy and the Signal Service.* Vol. I, No. I, November. 32 pp. 8vo. ($2 per year). Washington, D. C. (1721 G street).—This first number of a new journal contains the following articles: The Florida Cyclone of October, by Lieut. T. Smith, U. S. A., with two maps; Synopsis of the Report of the Chief Signal Officer; The great Oceanic Cyclones, by Prof. T. B. Maury; The Prussian and the French Field Telegraph, translated by Lieut. T. Smith; Description of a Self-recorder for Anemoscope and Anemometer, by Lieut. D. J. Gibbon, U. S. A.; Monthly Weather Review for October, with a map; Means of Barometer, Thermometer, Humidity, Wind, etc., for the month of October.

6. *Museum of Comparative Zoölogy at Cambridge, Massachusetts.*—The Museum of Comparative Zoölogy has been placed under the direction of Mr. Alexander Agassiz, son of Professor Agassiz, and Mr. Carey, both of whom are thoroughly conversant with Professor Agassiz's plans with regard to the Museum, and familiar with the collections.

7. *Walker Prize of the Boston Society of Natural History.*—The first award of the Walker prize of $1,000 has lately been made, by the Boston Society of Natural History, to Mr. Alexander Agassiz, for his recent researches and memoirs on the Echinoderms.

8. *Cave at Kutztown, Berks Co., Pa.*—About four miles from Kutztown, Pennsylvania, a cave has been recently discovered which affords handsome stalactites, equal, according to a letter from H. W. Hollenbush, to those of Mammoth Cave.

9. *Aurora Australis.*—The Aurora Australis was very bright at Melbourne, in Victoria, March 9th.—*Monthly Record of the Melbourne Observatory*, for March, 1873.

Transactions of the Connecticut Academy of Arts and Sciences. Vol. II, Part 2, pp. 209 to 410, 8vo, with 10 plates. New Haven, 1873.

Proceedings of the Academy of Sciences of Philadelphia. Part II. 1873.—Philadelphia, 1873.

Proceedings of the California Academy of Sciences. Vol. V, Part 1. 96 pp. with 2 plates. San Francisco, 1873.

Bulletin of the Buffalo Society of Natural Sciences. Vol. I, No. 3. Contains several zoölogical papers by Aug. R. Grote, and one on the Statistics and Distribution of North American Lichens, by Henry Willey.

Fifth Annual Report of the Trustees of the Peabody Academy of Science, at Salem, Mass., for the year 1872. 136 pp. 8vo. Contains several Entomological papers by A. S. Packard, Jr., also on the Cave Fauna of Indiana, by Mr. Packard; and a Record of American Entomology for 1872.

Investigation of the Orbit of Uranus, with general tables of the Moon, by Simon Newcomb, Prof. Mathematics, U. S. Navy. 288 pp. 4to. Smithsonian Contributions to Knowledge, No. 262.

On the Corrosion and Fouling of Iron Ships, by Robert Mallet, Esq., C.E., F.R.S., 64 pp. 4to. London, 1873.

Introductory Text-book of Physical Geography, by David Page; sixth ed. 232 pp. 12mo. Edinburgh and London, 1873. (Wm. Blackwood & Sons). Very poor in its geological chapter, and not very good in any other part.

The Galvanometer and its uses. A Manual for electricians and students, by C. H. Hawkins. 76 pp. 12mo (in pocket book form), with illustrations. New York, 1873. (D. Van Nostrand). A very full and convenient little manual.

A Catechism of High Pressure Steam Engines, including the modeling, constructing running, and management of steam engines and steam boilers, by Stephen Roper, Engineer. 218 pp. 12mo, with illustrations. Philadelphia, 1874. (Claxton, Remsen & Haffelfinger).

Mind and Body: The Theories of their Relations, by Alexander Bain, LL.D., Prof. Logic, Univ. of Aberdeen. 196 pp. 12mo. New York, 1873. Appleton's International Scientific Series.

OBITUARY.

AGASSIZ.—The death of Agassiz occurred soon after ten o'clock on Sunday night, December 14th, at his own house in Cambridge, after an illness which confined him only one week. He was attended by the best medical skill. His family physician, Dr. Morrill Wyman, and his old friend, Dr. Brown Sequard, were constantly with him. He died from nervous prostration, resulting in an attack of paralysis, affecting the respiratory muscles, and especially the pharynx.* His last public effort was an address before the Massachusetts State Board of Agriculture, at Fitchburgh, on Tuesday evening, December 2d, four days only before his prostration. He met his students on the 5th; and on Saturday, the 6th, while at work in the Museum of Comparative Zoölogy, he

* The details of the autopsy, which was made with great care, will be published hereafter. The base of the cerebellum was the seat of disease. The brain weighed entire about 1600 grams; free from blood and fluid, 1500 grams; considerably more than the normal average weight of the human brain.

was overcome with a sense of debility, and retired unaided to his house and his bed, never to leave them. He lectured not only with ease, before the State Board of Agriculture, but with an unwonted energy, even for him; an evidence, no doubt, of cerebral disturbance, of which many other proofs are known. But, the next day, the bad effects of his over-exertion were so evident that, by command of his physician, he relinquished an engagement to lecture at New Haven on the 8th.

Born on the 28th of May, 1807, Agassiz had attained only his 67th year. He was in his fortieth year when, in Oct., 1846, he landed at Boston, in the maturity of his reputation and of his remarkable intellectual powers. He came here at the suggestion of Baron Von Humboldt, who secured for his study of American geology and natural history a liberal appropriation from the King of Prussia. He first announced his intention to visit the United States in a letter to Prof. Silliman, dated at Neufchatel, Oct. 20, 1845. How great the change since, in his relations to the people and scientific men of America! He then wrote as follows: "After having finished all these numerous works in the study, I have truly need to replenish myself anew in the fields; and I hope to reap a rich harvest in your country. I know not how to thank you enough, my dear Sir, for all the information you have taken the trouble to send me; it has already been of great use to me in preparing myself for such a journey, and will serve me as a guide on my arrival in your country, where I have no relations or acquaintance among men of science. * * You are the only person in the United States with whom I maintain a correspondence. I wrote once to ———, and once to ———, without receiving any reply from the latter. * * All that you say to me of American naturalists and of their kindness, enchants me, and the time spent in America will surely be to me one of the happiest and most instructive epochs of my life." In a subsequent letter (dated Feb. 1st, 1846), he adds: "There is, in the prodigious activity of the Americans, something intoxicating, which has inspired me; and already I feel my youth renewed, in the anticipated contact with the noted men of your young and glorious republic." * * "Knowing the great desire I had to visit your country, and the impossibility of doing it at my own expense, his Excellency, the Baron von Humboldt, who has always treated me as a friend, and whose good counsels have been to me like those of a father, proposed to the King of Prussia to give me the necessary funds for the journey, which his Majesty granted to me in the most generous manner, furnishing me with a sum sufficient for a journey of two years, traveling alone. However, desiring to profit by this opportunity to gather as much as possible of the materials of the natural history of the United States, my intention is to have a *preparateur* and draughtsman accompany me, so as to have drawn from life all the fishes of your rivers and lakes, which have not yet been properly represented; and also the mollusks of your coasts, which have not been sufficiently studied. But, to provide for the extra expense, I shall be obliged to live very economically,

and in a manner little in accordance with the royal munificence which has furnished the means of making this journey. * * My sphere is entirely circumscribed by the scientific world, and all my ambition is limited to being useful to the branch of science which I particularly cultivate. With all this, I am no misanthrope; but I learned early that, where one has no fortune, one cannot serve Science and at the same time live in the world. If I have been able to produce numerous expensive publications, it has been only by following this system of economy and voluntary seclusion; and the results which I have obtained thus far have rewarded me so well for the privations which I have suffered, that I have no temptation to adopt another style of life, even should I have hereafter, and especially in your country, more trouble than I have had to sustain it in my own."

Recalling his wonderful success and influence in America, how interesting to read now these early utterances of his, in anticipation of a voyage which was destined to change his country for life, and lead to achievements so important to the cause of science and humanity, and so greatly transcending his utmost hopes! In full sympathy with all liberal and truly progressive ideas, he was not more ready to adopt the United States as his future home, after a brief residence, than this country was to accept and honor him. This decision was favored by the political commotions which, in 1848, unsettled everything in Europe. The single event, however, which perhaps more than any other determined him to remain in America, was an invitation from the late Chief of the United States Coast Survey, Prof. A. D. Bache, to accept the hospitalities of the steamers in that service, to explore the coasts of the United States on both sides of the continent. How joyously he accepted an invitation, so far exceeding his wildest dreams, is well known; and how rich have been the fruits thus gleaned for science is known as yet only in part, since the record of his last great exploration on board the Hassler, along both sides of the continent of South America and on the Pacific shores of Central America and the United States, remains yet to be published. This last great exploration was carried out in consequence of the enlightened policy of the present Chief of the Coast Survey, Prof. B. Peirce, in furtherance of the designs of his honored predecessor.

Of Agassiz's incessant labors in the cause of science, and his vast performances, especially since he made this country his home, it is not now our purpose to speak. Fitting record will be made of all these hereafter. Not this nation only, but the world, has suffered a great loss. More than any man since Cuvier and Von Humboldt, has he been known over the whole world. His fame arose alike from the great number and value of his original investigations and publications, from his ability as a philosopher, and from his power of inspiring others with his own enthusiasm. His life in the United States has awakened in thousands a zeal for the prosecution of scientific research, and beyond any other cause has promoted, and to a large degree created, that wonderful ac-

tivity which, in twenty-five years, has placed this country,—before without a museum of natural history, a zoological laboratory, or a well organized Scientific school—in the front rank of scientific activity.

Long have we dreaded the sad event which we now record. Many years since, the splendid physique of Agassiz showed evidence that his prodigious labors were overcoming his elasticity. His herculean strength, which had made him a stranger to fatigue of body or mind, yielded to the severer tax of the American climate, and the incessant growing demands upon him from every source. His life and strength were renewed by his long voyage to San Francisco, in the Hassler; but both he and his friends have recognized the fact that to labor with his former activity was impossible and forbidden. Yet to live was for him, unavoidably, to labor; and to die in the harness, rather than to live after the power to serve his fellow men was passed, his aspiration.

An excellent sketch of Agassiz's life and labors, prior to 1860, will be found in the New American Cyclopedia, under his name; and a full list of his publications down to 1866, is contained in the Royal Society's Catalogue of Scientific Works.

His funeral was attended on the 18th of December, from Appleton Chapel at Harvard University, without ceremony, and in a touching simplicity of style quite in harmony with his life, by a vast assembly of mourning friends from Boston and many neighboring and distant cities. The flags of the municipality of Boston were hung at half mast; and the bells were tolled during the obsequies. No eulogy was pronounced: the voice of the officiating clergyman broke the silence with the words: "I am the resurrection and the life." To the solemn music of the "Dead March in Saul," the family and a few near friends, with the University authorities, left the chapel for Mount Auburn Cemetery, where now rests, by the side of his much loved friend, President Felton, all that is mortal of Louis John Rudolph Agassiz.

Agassiz's death cuts short his discussion of the doctrine of "Evolution and Permanence of Types," the first paper of which appeared in the Atlantic Monthly for the month of December. How like a voice from another world sound now these words concluding his summary of Darwin's publications: "I can only rejoice that the discussion has taken this turn, much as I dissent from the treatment of the subject. It cannot be too soon understood that science is one, and that whether we investigate language, philosophy, theology, history, or physics, we are dealing with the same problem, culminating in the knowledge of ourselves. Speech is known only in connection with the organs of man, thought in connection with his brain, religion as the expression of his aspirations, history as the record of his deeds, and physical science as the law under which he lives. Philosophers and theologians have yet to learn that a physical fact is as sacred as a moral principle. Our own nature demands from us this double allegiance." S.

Dr. Karl Friedrich Naumann, the eminent crystallographer and mineralogist, died at Leipzig on the 26th of November.

APPENDIX.

ART. XII.—*On the Structure and Affinities of the Brontotheridæ;* by O. C. MARSH. (With two plates.)

THE Miocene deposits on the eastern slope of the Rocky Mountains contain the remains of a group of gigantic mammals, of much interest, which have been named by the writer, *Brontotheridæ.** Although these animals are less remarkable than the *Dinocerata* of the Eocene,† which they seem to have replaced, they equalled them in size, and resembled them in several important features, notably in the structure of the feet, and in having the head armed with a pair of powerful horns. The general structure of the group, however, clearly indicates that they do not belong in the order *Dinocerata*, but should be placed with the Perissodactyls, in which they form a well-marked family.

The more prominent characters of this family were pointed out by the writer in describing *Brontotherium gigas* Marsh, the type species, and others had been previously mentioned by Dr. Leidy in his descriptions of *Titanotherium Proutii.*‡ The skull of the latter genus is not known, but there can now be no reasonable doubt that it was furnished with horns, in some respects similar to those of *Brontotherium* (Plates I and II). The possibility of this was originally suggested by Dr. Leidy,§ and in his latest work he has figured a horn-core from the same deposits which yielded the *Titanotherium* remains.‖ The fragmentary specimen described by Dr. Leidy as *Megacerops Coloradensis*,¶ probably belongs in the same family, but until additional remains are found this point cannot be decided. The supposed genera *Symborodon* and *Miobasileus*, recently indicated by Prof. Cope (Am. Nat., vii, p. 753), belong to this group. The former is generically identical with *Brontotherium*, the reputed absence of lower incisors being evidently due either to age, or to imperfect specimens. *Miobasileus* is apparently the same genus, and hence both names should be regarded as synonyms of *Brontotherium*.

* This Journal, vol. v, p. 486, June, 1873.
† Loc. cit., p. 117, Feb., 1873.
‡ Extinct Mammalia, p. 206, 1869.
§ Loc. cit., p. 216.
‖ Extinct Vertebrate Fauna, Pl. XXVIII, fig. 3, 1873.
¶ Proceedings Phil. Acad., 1870, p. i, and Extinct Vertebrate Fauna, p. 239.

Among the more marked characters of the *Brontotheridæ*, which readily distinguish them from the *Rhinocerotidæ*, apparently their near allies, may be mentioned the following:—There are four short and thick toes in the manus, and three in the pes. The skull supports a pair of large horn-cores, placed transversely, as in modern Artiodactyls.* There are well developed canine teeth in both jaws. The molar teeth, above and below, are not of the *Rhinoceros* type, but resemble those of *Chalicotherium*.

The general characters of the *Brontotheridæ* are fully shown in a large series of specimens in the Yale College Museum. The cranial structure of *Brontotherium*, the type genus, is well illustrated in the nearly perfect skull of *B. ingens* Marsh (Plates I and II), described in this article. The only other genus of the group known with certainty is *Titanotherium* of Leidy (*Menodus* Pomel), which, according to the descriptions of that author, differed essentially in having four lower premolars, and in the absence of a third trochanter on the femur. Less important differences are seen in the composition of the teeth, and in the diastema between the upper canine and first premolar.

The skull in *Brontotherium* is elongated, and resembles in its general features that of *Rhinoceros*. The occipital region is greatly extended vertically, and deeply concave posteriorly. The brain cavity is unusually contracted. The vertex is concave longitudinally, and convex transversely (Plates I and II). The zygomatic arches are massive, and much expanded. The orbit is small, and continuous with the elongated temporal fossa. The nasals are greatly developed, and firmly coössified. They support entirely, or nearly so, the large divergent horn-cores. Their anterior extremities are produced, and overhang the large narial orifice. The premaxillaries are diminutive, and do not extend forward so far as the end of the nasals. The palate is deeply arched above, especially between the premolars. The posterior nares extend forward nearly to the front of the last molar. The lachrymal forms the anterior margin of the orbit. The malar extends forward beyond the lower margin of the orbit. The infra-orbital foramen is large, and situated well forward. The zygomatic process of the squamosal is elevated, and incurved above. There is a large post-glenoid process, and a massive, and somewhat shorter paroccipital process (Plate I). The posttympanic process of the squamosal is large, and quite external to the paroccipital process. The occipital condyles are large, and well separated.

* *Rhinoceros pleuroceros* Duv., from the Miocene of France, has a transverse pair of small horn-cores on the nasals, not unlike those in *Dinoceras*. *R. minutus* Cuv has somewhat similar processes.

The mandible has a wide condyle, and a slender coronoid process. The angle is rounded, and slightly produced downward. The symphysis is depressed, elongated, very shallow in front, and completely ossified.

The dental formula of *Brontotherium* is as follows:—

$$\text{Incisors, } \frac{2}{2}\text{; canines, } \frac{1}{1}\text{; premolars, } \frac{4}{3}\text{; molars, } \frac{3}{3} \times 2 = 38.$$

The upper incisors are quite small. The canine is short and stout, and placed close to the first premolar. The latter is proportionally much larger than the corresponding tooth in *Titanotherium*. The upper premolars have all essentially the same structure, viz: two external connate cusps, with their outer faces nearly plane, and two inner cones closely united. The anterior cone is connected with the opposite outer cusp by a transverse ridge, which has behind it an elongated depression, more or less divided by projections from the outer posterior cusp. In the upper true molars, the external cusps have their outer surfaces deeply concave, while the inner cones are low and separate. The lower incisors were small, and evidently of little use. The two next the symphysis were separated from each other. One specimen in the Yale Museum has the crown hemispherical in form The lower incisors are not unfrequently wanting, and in old animals the alveoli may, perhaps, disappear. Careful examination, however, will usually show indications of them. The lower canine is of moderate size, and separated from the premolars by a short diastema. The lower molars are of the *Palæotherium* type, and agree essentially with those of *Titanotherium*.

The head in *Brontotherium* was declined when in its natural position. The neck was stout, and of moderate length. The cervical and most of the dorsal vertebræ are distinctly opisthocœlous. The latter are in general elevated. The atlas is large, and much expanded transversely. The axis is massive, and has its anterior articular faces much broader than in the *Dinocerata*. The odontoid process was stout and conical. The transverse process was small, and apparently imperforate. The posterior articular face is concave, and oblique. The epiphyses of the vertebræ are loosely united in most specimens, as in the Proboscidians. The caudal vertebræ preserved indicate a long and slender tail.

The limbs of the *Brontotheridæ* were intermediate in proportion between those of the Elephant and the Rhinoceros. The humerus is stout, and its entire distal end is occupied by the articulation. The olecranon cavity is shallow, and the condylar ridge similar to that of the Elephant, but not continued so far up the shaft. The ulna has its olecranon portion much compressed. Its distal end is much smaller than in *Rhinoceros*, and

has no articular face for the lunar. The radius is stout, and its distal end expanded. The carpal bones form interlocking series. They are shorter than in *Rhinoceros*, and support four well developed toes of nearly equal size. The metacarpal bones are shorter than those of the *Rhinoceros*, the first phalanges longer, and the second series shorter. The ungual phalanges are short and tubercular, as in the Elephant.

The femur has a small third trochanter, and its head a deep pit for the round ligament. At the distal end, the anterior articular surface is narrow, and the two edges are of nearly equal prominence, as in the Tapir. There is a small fossa on the posterior side above the outer condyle. The tibia is stout, and has a distinct spine. The fibula is entire, but quite slender. The astragalus is shorter than in the Rhinoceros, and the superior groove more oblique. There is a deep pit near the center of the outer surface. The cuboid face is larger than in *Rhinoceros*. The navicular has its distal facets subequal. There were three toes of nearly equal size in the pes, the first and fifth being entirely wanting.

In comparing the *Brontotheridæ* with the equally gigantic *Dinocerata* of the Eocene, several striking points of resemblance will be at once noticed: especially the presence of horns in transverse pairs; the general structure of the limbs and feet; and particularly the short and thick toes. The differences, however, between these two groups are still more marked. In the *Brontotheridæ* there is but a single pair of horn-cores, and no crest around the vertex. The structure and number of the teeth are quite different, while the small canines and huge molars contrast strongly with the elongated canine tusks, and diminutive molars of the *Dinocerata*. The latter, moreover, have two very large dependent processes on each ramus of the mandible; the cervical vertebræ flat; the femur without a third trochanter; and an additional toe in each foot.

Among the features which this group shares with the *Proboscidea* may be mentioned: the superior extension of the condylar ridge of the humerus; the short thick toes; and the late union of the epiphyses with the centra of the vertebræ. The last character appears to belong especially to mammals of very large size, and probably indicates late maturity, and great longevity.

The preceding description makes it evident that the *Brontotheridæ* constitute a very distinct family of the *Perissodactyla*. While retaining some prominent features of their Eocene predecessors, the *Dinocerata*, they are more nearly related to the Rhinoceros family, and at the same time they have some characters allying them to the *Proboscidea*, which replace them in the succeeding, Pliocene period.

All the known remains of the *Brontotheridæ* are from east of the Rocky Mountains, in the Miocene beds of Dakota, Nebraska, Wyoming and Colorado. The specimens here described are mainly from localities in the "Bad lands" of Colorado, which were discovered and explored by the writer in the summer of 1870.*

Brontotherium ingens, sp. nov.

A new and well marked species of *Brontotherium* is represented in the Yale College Museum by a skull, nearly perfect, and other characteristic remains. The specimens preserved indicate that the animals to which they pertained were much the largest of the group, nearly or quite equalling the elephant in bulk, and far exceeding in size any known Perissodactyls living or fossil.

The skull in the type specimen of the species is well represented in the accompanying plates, and its general characters have already been given. The most striking peculiarity of this cranium is the pair of huge horn-cores on the nasals. They are about eight inches in length, and extend upward and outward. They are triangular at the base, with the broadest face external. The two inner faces of each core are separated by a ridge, which is continued to the median line. The upper part of the horn-cores is rugose, and the base contains large air cavities. The free extremities of the nasals are coössified, and much elongated. They are rounded in front, slightly decurved, and the surface at the end is rugose. The orbit is of moderate size, and looks forward, outward, and upward. The lachrymal foramen is small, and ovate in outline. Just below it, there is a depression of similar form. The infra-orbital foramen is unusually large. There is no post-orbital process. The zygomatic arches are massive, and the squamosal portion widely expanded. The temporal fossa extends far backward, and has over its posterior portion an obtuse ridge. The occipital condyles are very large, wide apart, and extend slightly behind the supra-occipital crest. The paroccipital process of the squamosal is elongate, and its anterior face concave. The postglenoid process is very large, much extended transversely, and is longer than the paroccipital process.

The premaxillaries in this cranium are imperfect, and the incisors wanting. The canines, also, are not entire, but they were only of moderate size, and in close proximity to the first premolar. This tooth had two fangs, and resembled the other premolars. All of these have a strong inner basal ridge. The crowns are more nearly square than in *Titanotherium Proutii* Leidy. The upper true molars are very large, the last especially

* This Journal, II, vol. l, p. 292, Sept., 1870.

so. It resembles the corresponding tooth in *T. Proutii*, but the inner posterior angle of the crown is much more developed.

The limbs in this species were shorter than those in the existing elephants, which, in form of body, it doubtless resembled. The huge divergent horns, and the absence of tusks, gave the head a very different appearance. The wide narial opening, the rugose extremities of the nasals, and the very large infra-orbital foramen, naturally suggest that there must have been an elongated, flexible nose, possibly as extensive as in the Tapir. That there was no long proboscis, as in the Elephant, is indicated with equal certainty by the length of the head and neck, which renders such an organ unnecessary.

The principal dimensions of the skull represented in plates I and II are as follows:—

Measurements.

Length of skull from occipital condyles to end of nasals (36 inches),	915·mm
Distance from posterior margin of occipital crest to front of horn-core,	762·
Distance on median line from occipital crest to end of nasals,	762·
Width between extremities of horn-cores (20 inches),	507·
Expanse of zygomatic arches,	558·
Least distance across vertex,	157·
Space occupied by four upper premolars,	162·
Space occupied by three upper true molars,	266·
Antero-posterior diameter of last upper molar, on outside,	117·
Antero-posterior diameter, through center,	112·
Transverse diameter,	114·
Antero-posterior diameter of fourth upper premolar,	53·
Transverse diameter,	69·
Antero-posterior diameter of third upper premolar,	48·
Antero-posterior diameter of second upper premolar,	37·
Antero-posterior diameter of first upper premolar,	26·5
Width across palate between second premolars,	55·
Width across palate between last upper molars,	115·
Space between outer faces of last upper molars,	330·
Greatest height of zygoma,	145·
Height of zygoma at anterior extremity of malar suture,	90·
Greatest diameter of occipital condyle,	120·
Least diameter,	75·
Distance between outer margins of occipital condyles,	204·

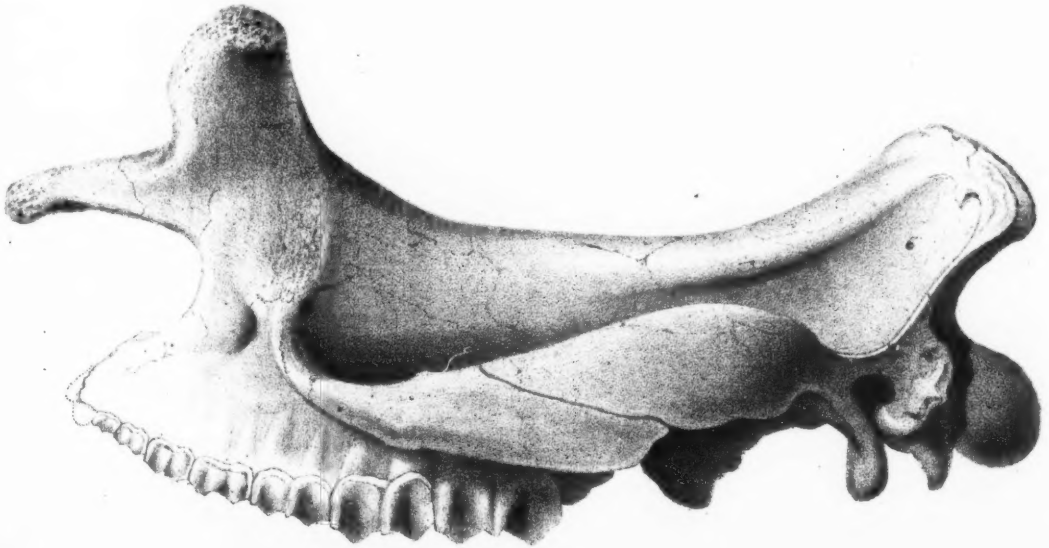
All the known remains of this species are from the Miocene of Colorado, and are preserved in the Yale Museum.

Yale College, Dec. 24th, 1873.

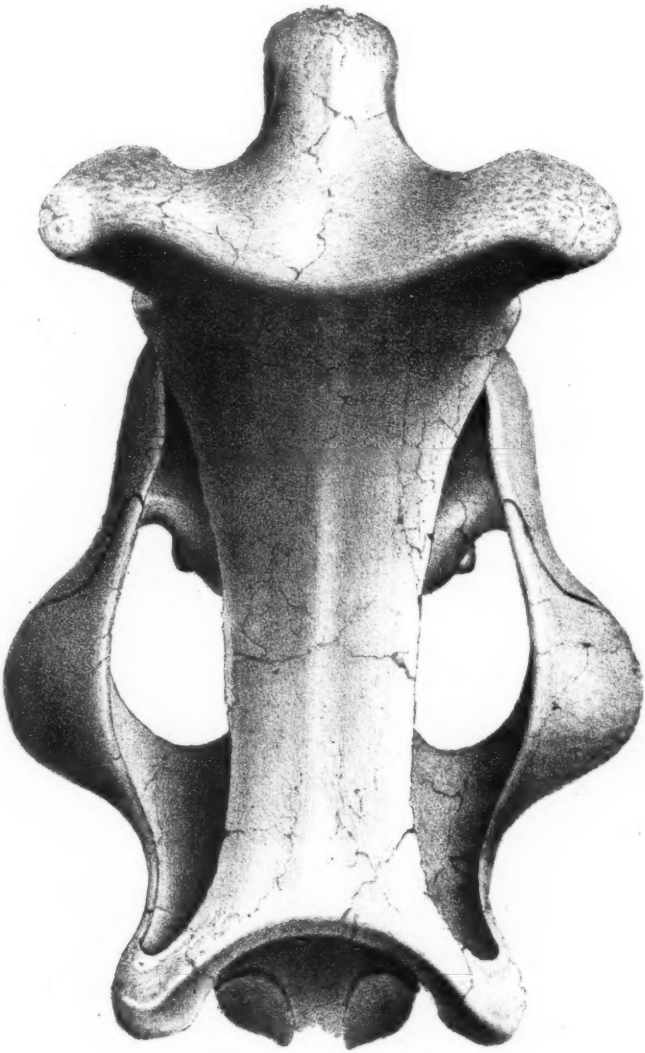
EXPLANATION OF PLATES.

Plate I. *Brontotherium ingens* Marsh. Side view. One-sixth natural size.
Plate II. *Brontotherium ingens* Marsh. Top view. One-sixth natural size.

PLATE I.

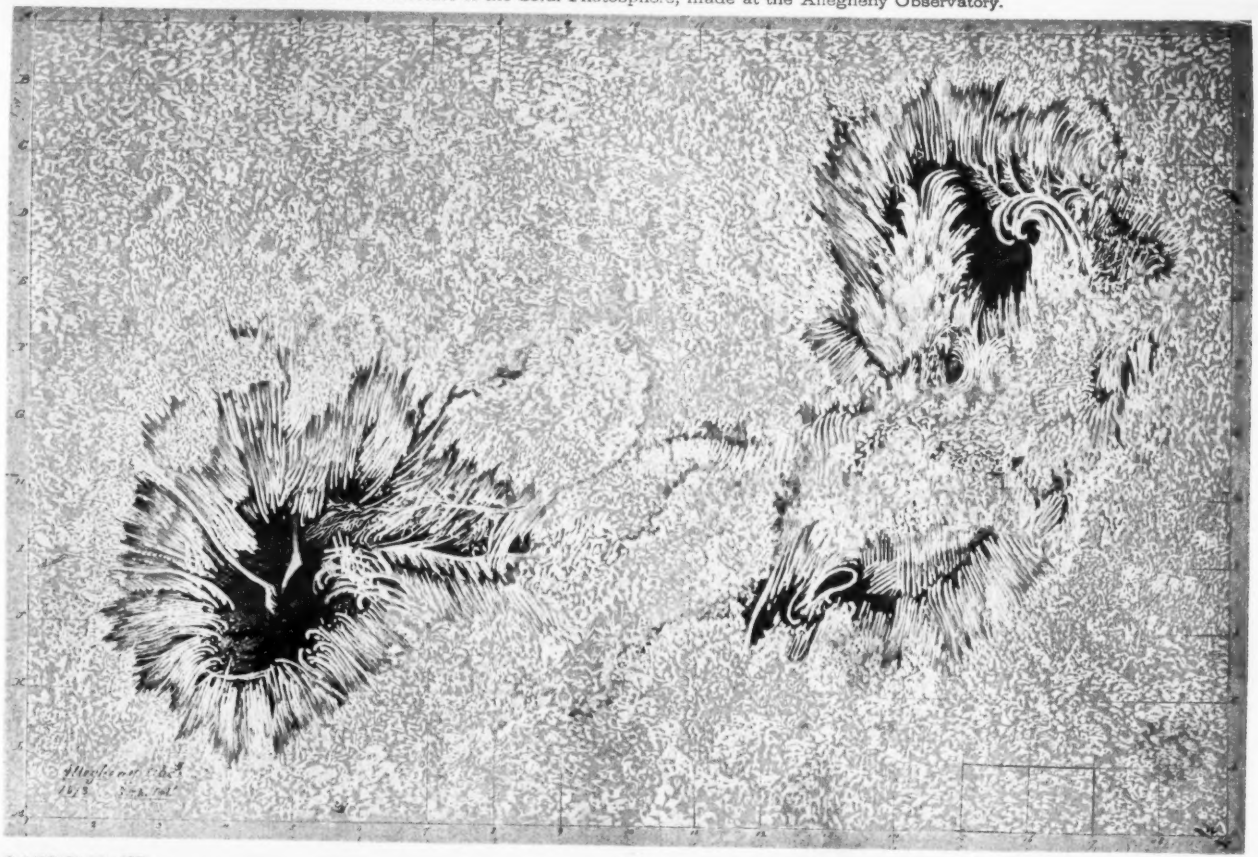


BRONTOTHERIUM INGENS, Marsh. ½



BRONTOTHERIUM HORRIDUS PLATT

Studies of the minute structure of the Solar Photosphere, made at the Allegheny Observatory.



S. P. LANGLEY, DEL. 1873.

E. BIERSTADT, ALBERTYPE.